POWER

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Merit and Influence

Just to be the maker of the finest mousetraps is no assurance these days that there will be a well-worn pathway to one's front door. To be sure this aphorism still has philosophic appeal but with the development of modern business the trail has certainly been obscured.

For one thing, trade in the power machinery business is dependent upon much more than mere merit of product. Nor is salesmanship, in the dictionary sense, what it used to be when Noah Webster was a boy.

Few contracts of consequence nowadays are not colored by some form of backstage influence. This fact, while a natural development among the larger power machinery users and vendors, does not always achieve the best results technically.

From the viewpoint of the power engineers responsible for operating economy, it is sometimes a discouragement and a handicap, particularly when the order is placed by executive fiat without regard to the engineering recommendations.

Then there comes the realization, among some of the competing manufacturers, that they have been playing the game with a stacked deck. If the so called smaller manufacturer is to avoid this experience, it behooves him to capitalize the natural advantages of his position, and so give greater force to the recommendations of the purchaser's engineers as these men *are really the vendor's advocates at headquarters.*

In addition to making a quality product, the smaller manufacturer should develop a reputation for giving individualized service and highly efficient attention to the particular ideas and requirements of the purchaser's engineers. He should make them feel the satisfaction and pleasure of direct dealings with a top executive who combines the ultimate power of decision with the technical capacity to discuss problems on an equal footing. He should impress the engineers with his reliability, prompt action when delays mean money, and readiness to remedy errors.

These are just a few of the attributes that bring business and that can be capitalized to advantage since they are much more difficult to secure in large organizations than small.

EDITORIALS

The Smoke Problem Will Not Wait

"The smoke goes up the chimney just the same." "Its a bad thing." On these two points, and these only, do the smoke doctors agree.

Ask what is this "smoke" that causes such damage to health, wealth and morale and you get many answers. Most will agree that carbon is a primary culprit. Yet the ash is worse, some say, while still others insist that the invisible sulpurous gases come first.

Added to these divergencies of definition are the difficulties of smoke measurement—even the difficulty of deciding what to measure and where to find it.

Finally, which chimneys are chiefly to blame for this indefinable crime against humanity? Are utility and factory stacks the prime offenders, or do domestic stacks, individually trivial, tip the scales by sheer weight of numbers? How important is the smoke from locomotives and roundhouses, or from tugboats and vessels in harbors? Not one of these questions has been answered to the satisfaction of all concerned.

Yet in the face of this confusion of understanding something will be done now. The physician, confronted with a sick patient, cannot wait for the perfection of medical knowledge or surgical technique. He must do the best he can with what he has, praying that future patients will benefit from research now in progress.

The same with smoke, fly ash and other pollutants. It is highly important that smoke research be pressed forward with increased vigor to arrive at definitions, units and scales in accord with physical, chemical and physiological facts. It is equally important, for the present generation at least, that the best known rough-and-ready methods of combating smoke, and other pollutants as well, be vigorously applied now.

Steam Piping Design

A few years ago it was quite the usual practice for the designing engineer to run his pipe lines about the plant in such manner as was convenient. He provided for expansion by placing bends of such form as pleased his fancy and where he thought they were needed. The radii were often chosen from catalogs. The anchoring was generally indicated but the means for hanging or supporting the pipe was often left to the judgment of the erector.

This procedure is still followed on some jobs, but the introduction of higher steam pressures and temperatures has led to a departure from these simple methods. Mathematical analyses are now being applied to piping problems. Bends are designed so as to take up a given expansion while the resultant thrusts upon the supports, anchors, or building are carefully calculated and provision made to withstand them. Even the flanges and the bolts are proportioned to meet incident stresses. Heat insulation is approached in like manner.

This care in the design of piping, while involving somewhat higher first cost than the old methods, gives a better layout and leads to better piping than formerly. That one now seldom hears of a serious piping failure is significant.

As still more laboratory and service data in verification of mathematical analyses become available the fundamentals will gain wider acceptance and be more generally applied. Engineers have not exhausted, by any means, the application of such procedure to piping problems, although steady progress is being made.

School Ventilation Again Jeopardized

Again the New York State Legislature has passed an act to amend the law that prescribes the ventilation requirements in public schools. This act removes the only safeguard the present law contains, namely, that at least thirty cubic feet of pure air per minute shall be assured for each pupil and that facilities shall be provided for the positive removal of vitiated air. If the amendment is approved by the Governor the decision as to what is and what is not proper ventilation will be left to political appointees who are not engineers, and the purpose of the law will be defeated.

At the last annual meeting of the Heating and Ventilating Engineers there was presented a code on ventilation standards. Although this code was not approved, it is significant that the minimum quantity of fresh air specified was ten cubic feet per minute per person. Thus, in the light of present-day knowledge and methods of ventilation, the unamended law requires more ventilation than actually needed, indicating that revision of the law is in order.

If, in the amendment, there had been included a definition of what constitutes proper ventilation, much of the opposition against this bill would be satisfied.

Last year when this amendment was passed the Governor wisely vetoed it. As this issue goes to press he is being urged to veto the measure again and to continue to do so until there is incorporated in it a satisfactory statement as to minimum requirements.

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POWER Stands for . .

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

92-98% of Dust in Flue Gases Removed at Michigan City Plant

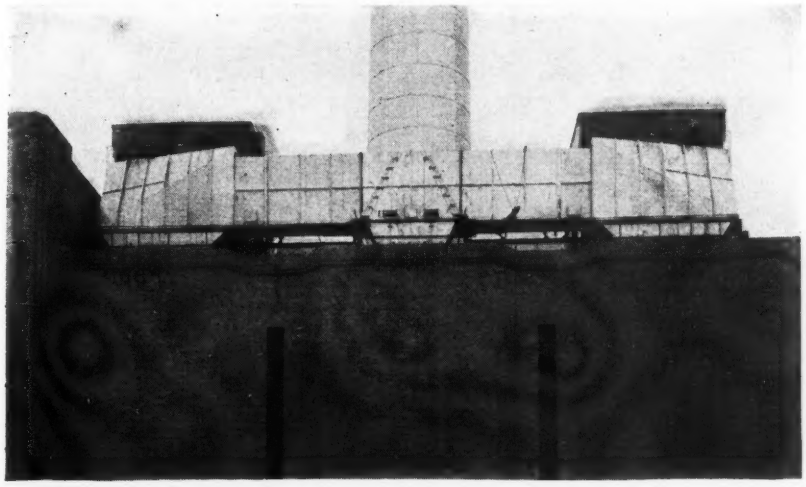

Fig. 1—Precipitator installation on roof of Michigan City plant

ALMOST successful installation for the recovery of pulverized-coal ash from flue gases has been in operation for about a year at the new electrical generating station of the Northern Indiana Public Service Company in Michigan City, Ind. According to an extended series of tests separation efficiencies range from 92 to 98 per cent, depending upon the load, and so far as visual evidence goes, it is difficult to tell by the appearance of the stack that the plant is in operation. Such excellent results were obtained by building precipitators somewhat larger than the normal for 90 to 95 per cent recovery. In this way gas velocities in the collectors are reduced sufficiently to improve the effective clean-up by the margin indicated.

The initial installation in this plant consists of a single turbine-generator of 68,000 kw. capacity. Steam at 650 lb. and 750 deg. F. is supplied by three cross-drum boilers, having steaming economizers and tubular air heaters. The furnaces, each with a volume of 14,700 cu.ft., are of the slag-tap type, the walls being water-cooled and the furnace bottoms air-cooled in one case and water-cooled in the other two furnaces. Pulverized coal from two 12½-ton unit mills per boiler is horizontally fired.

Indiana coal is used, practically all of which comes from the No. 7 seam in the Sullivan-Linton district. The following general mine analyses indicates the quality: Fixed carbon, 41.8; volatile, 35.2; moisture, 13.8; ash, 9.2 per cent. The sulphur content is 3 per cent and the heat value 11,150 B.t.u. per pound.

A Cottrell electrical precipitation system has been installed. An ingenious arrangement of special distributing ducts, dampers and division plates, made it possible to use two precipitators for the three boilers, thereby reducing the investment. Each collector may serve one and one-half boilers although it is capable of handling at lower efficiency the flue dust from two boilers steaming at maximum load. Ordinarily, however, station conditions require only two boilers at a time, so that normally each precipitator is required to handle the gas from one boiler. This means that for the most of the time each precipitator is working at a point in the efficiency curve where the collection probably is better than 95 per cent.

With bulky equipment of this character that can be placed outside with immunity, and in so doing save building space, a roof location was favored. It fitted in with the general design of the boiler plant and gave short direct duct connections. The economizers, and preheaters are back of the boilers, the forced- and induced-draft fans on a level above them, and in line on the roof are the precipitators.

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Two electrical precipitators arranged to serve three boilers. Factors responsible for the remarkable efficiency are specially designed system of distributing ducts and division plates to insure uniform gas distribution over the entire area of the eliminator inlet, and the slowing down of gas velocities to 8 ft. per sec. at the specified capacity of the precipitator, namely 165,000 cu.ft. of gas per minute

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One of the fundamental requirements for proper operation of a Cottrell dust precipitator used in connection with a pulverized fuel boiler is, that the gas volume should be distributed uniformly over the entire inlet area. With the limited provision for weight and the limited space for inlet duct connections, a special design of duct system to fulfill these requirements was created.

Discharge connections from the three induced-draft fans extend vertically through the roof. In the 11-ft. 9-in. vertical section of each duct above the roof line, where it flares out to the box-shaped precipitator

inlet, as indicated in section *AA*, Fig. 2, division plates spread out like the ribs of a fan to give gas distribution over a horizontal plane. From the drawing which shows a symmetrical half of the installation, it will be evident that three risers intersect a horizontal section of breeching on the roof extending across the three boilers. The precipitators are located almost directly over the two outside risers. Gas from the central boiler is deflected to the right and to the left horizontally by a double system of adjustable dampers by which distribution is achieved in a vertical plane. In case it is desired to direct all gases from the middle boiler to one precipitator, one set of inclined dampers is closed, while the other set acts as distribution vanes. With three boilers in operation, both sets are open and act as distribution vanes to divert the gases from the middle boiler half to the left precipitator and half to the right precipitator.

At the entrance to each precipitator is a series of vertical shaft dampers controlled by an air cylinder which permits shutting off the precipitator for overhauling or repair. Immediately in front of this damper area is a 2-ft. section of duct divided by three vertical and three horizontal baffles into sixteen equal rectangles. This portion of the duct serves as a straightening vane to direct the gases horizontally into the precipitator proper. In front of this 2-ft. section is a 6-ft. 5-in. section of duct containing the main distribution baffle plates. The distribution box is peculiarly shaped. Because the distribution plates are inclined both horizontally and vertically, one entire side of the duct in the shape of a triangular pyramid is useless for gas carrying and has been eliminated to save weight. These plates, shown in the isometric view of the duct at the precipitator in Fig. 2, are all flat and shaped only for intersection with the sides of the duct. They are held in position by staybolts extending through to the stiffeners on the outside duct walls. The plates are so arranged as to deflect all gas from a given area entering the distribution box to a corresponding area leaving the distribution box. Provision also is made so that the area between distribution plates entering the distribution box is proportional to the area between the same two plates leaving the distribution box. In other words, a section of area cut out at the inlet to the distribution box bears the same relation to the entire area at the inlet that the section cut out by the same plates at the outlet does to the entire area at the outlet. This is true no matter whether the inlet is at the right of the distribution box, taking the gas from the central boiler, or whether it is at the bottom of the distribution box, taking gas from an outside boiler.

In Fig. 2, section *BB* shows the appearance of these

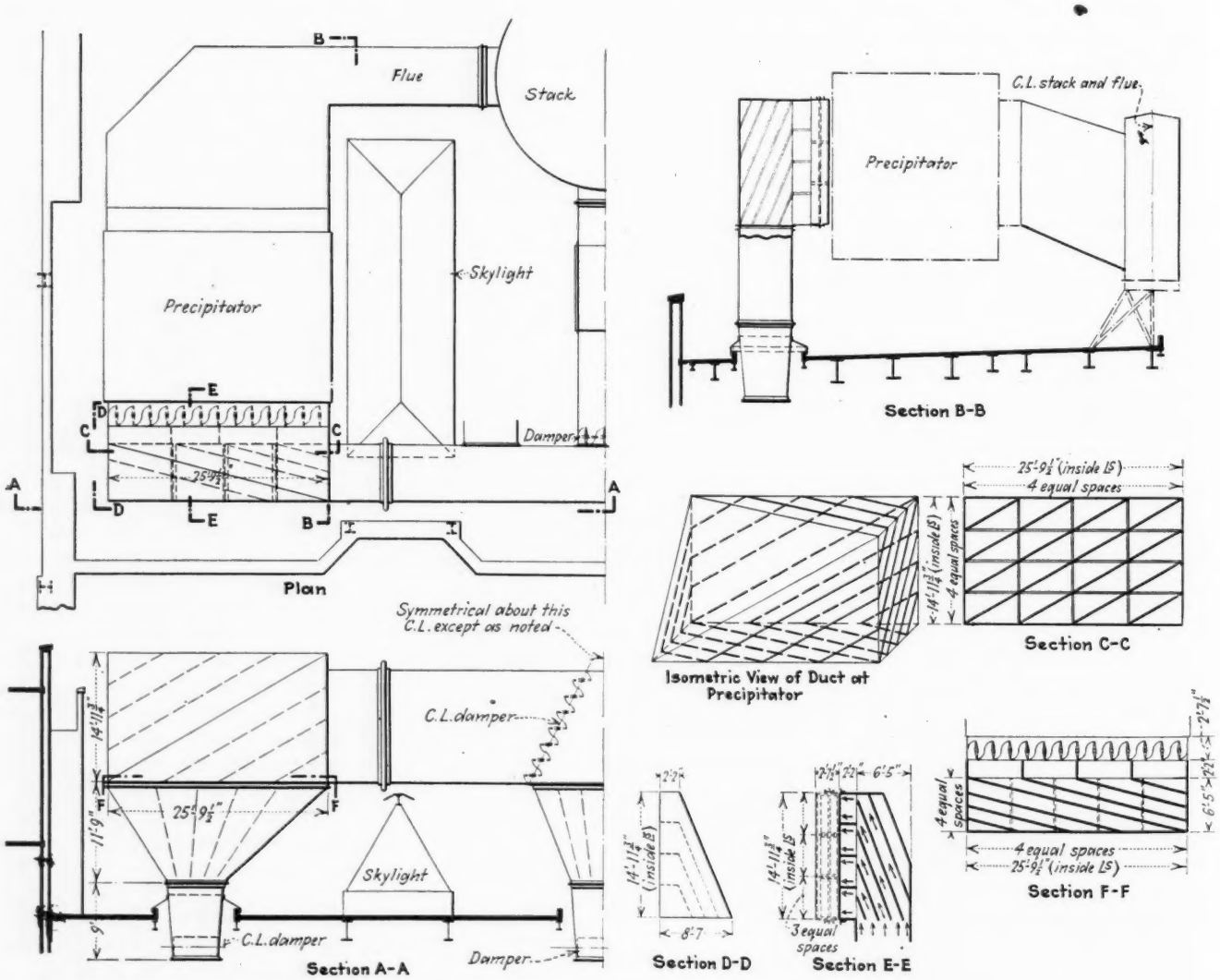


Fig. 2—Duplicate half of precipitator installation with sections to show arrangement of deflector plates on duct system

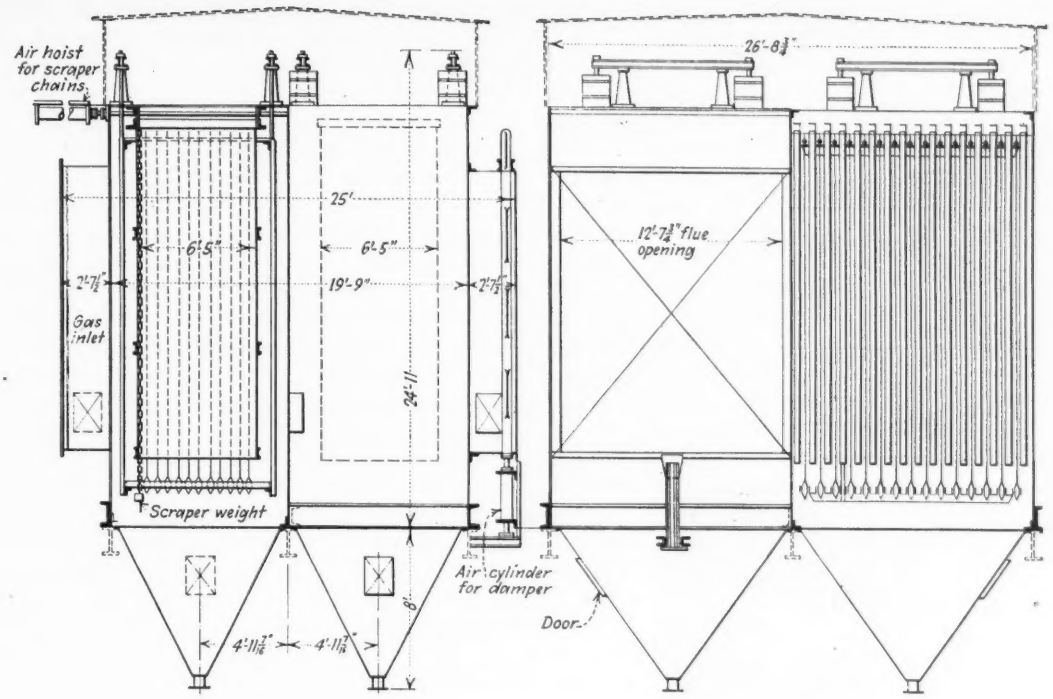


Fig. 3 — Construction and dimensions of eliminator indicated by these two views in part section

division plates in the distribution box as presented to the gas coming from the central boiler. Section *DD* shows the plates as presented to the gas coming from an outside boiler. Section *EE* illustrates the path of the gas coming from an outside boiler. Section *CC* shows the arrangement of baffles immediately in front of the 2-ft. neck and indicates the restriction of angular motion provided at the straightening vanes.

After the gas has passed through the precipitators it passes through an outlet neck containing another set of vertical shaft dampers and from there through a gunite-lined breeching to the stack.

The precipitators are of the graded-resistance horizontal-flow type using plates of Haydite cement as the collecting electrodes. These 2-in. slabs are suspended vertically in parallel with each other on 10-in. centers to form intervening ducts through which the gases pass horizontally. In each cement slab vertical steel members are imbedded on about 6-in. centers and are electrically connected to ground. From an insulated top suspension negative-wire, or discharge, electrodes on the same spacing but staggered with the steel members, hang between the plates, with a 20-lb. weight on the end of each wire to hold it taut and guides and stiffeners to prevent swinging.

As the gas passes through the electrical field maintained by the use of unidirectional current at high voltage, it becomes ionized and each dust particle is given an electrostatic charge which causes it to move toward the grounded electrode and thus collect on the cement slabs. With the graded resistance type of precipitator the apparatus is practically self-cleaning, as usually the dust falls of its own weight when the deposit on the plates reaches the necessary thickness. Chain scrapers operated by a common air cylinder are provided, however, as a safeguard. In the present installation they are operated once each shift of eight hours.

Each precipitator is divided into four sections, two in tandem with fifteen ducts on each side of a longitudinal steel partition, so that either half of the collector may be blocked off a few minutes for cleaning while the other half is maintained in operation.

With the precipitator in full operation the gas passes through thirty parallel ducts, each 8 in. wide and having an effective height of 17 ft. 6 in. to give a cross-sectional area of 350 sq.ft. The plates are 6 ft. 5 in. long, so that the effective length of treatment is 12 ft. 10 in. Allowing for the high-voltage frame work and space for dampers, gives a two-unit precipitator 26 ft. 8¾ in. wide, 25 ft. long in the direction of the gas flow and 32 ft. 11 in. high including insulators and ash hoppers. The total approximate weight of each precipitator without reclaimed material is 136 tons.

Usually equipment of this type is designed on the basis of passing 6,000 cu.ft. of gas per minute through each duct. With the thirty ducts in the present installation this would mean the passing of 180,000 cu.ft. of gas per minute and a separation efficiency of 90 to 95 per cent. With a view towards improving this high percentage of separation 165,000 cu.ft. of gas per minute was specified as the precipitator capacity. This figure reduces to 5,300 cu.ft. per minute per duct and to a gas velocity of 7.86 ft. per sec. as compared to the usual 8.6. Other conditions remaining the same, it will be understood, of course, that efficiency of separation increases inversely as the velocity of the gases. The foregoing quantity of gas would be obtained in this plant with the boiler output approximating 345,000 lb. of steam per hour, and at this rating the gas temperature at the precipitator approximates 360 deg. Increasing the quantity of gas to 240,000 cu.ft. per minute, equivalent to a boiler output of 500,000 lb. of steam per hour and a gas temperature of 400 deg. at the collector, the velocity of gas travel reaches 11.43 ft. per second, or 8,000 cu.ft. per minute per duct, which is still within design standards for effective clean-up.

Four hoppers under each precipitator collect the fly ash and dust separated from the gases. By means of screw conveyors and gravity transfer is made to a storage hopper under the roof of the boiler room, from which

the ashes drop by gravity to a sluicing trench installed in the boiler-room basement primarily to handle the granulated slag from the furnaces. This sluiceway discharges to a small tank within the basement, serving as a suction basin for two automatically controlled vertical ash pumps whose discharge is used as fill on the property.

A difficulty which has been experienced in the past from absorption of moisture by the dry ash between dumping periods, has been overcome in this installation through the use of specially designed, rubber-seated butterfly valves in the vertical lines from the storage hoppers, the location of the valves being near the sluiceway.

For each precipitator there are two electrical units, a switchboard with electrical instruments and controls

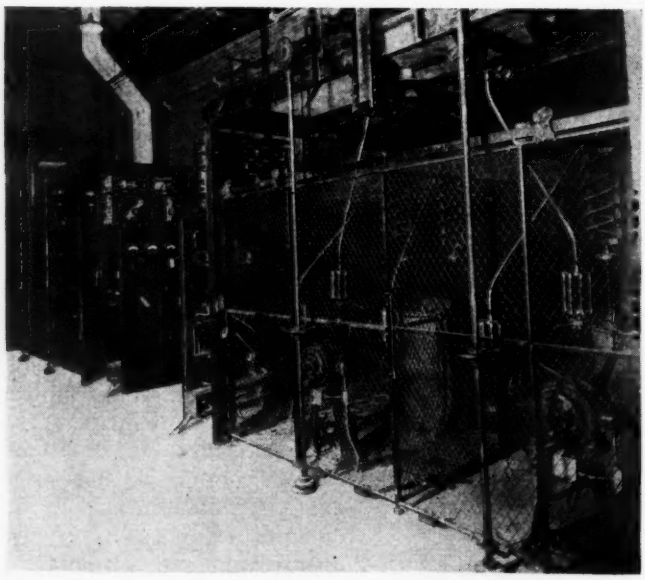


Fig. 4—High-tension electrical equipment in wire inclosure

and adjacent panel boards for compressed-air valve control and damper interlocks, so that the attendant may operate the entire unit from a central point. Each electrical unit consists of a 25-kva. transformer which steps up a single phase of the 440-volt station supply to 75,000 volts, with low-voltage taps for adjustment to a normal operating voltage of 57,000 by transformer ratio; a motor-driven mechanical rectifier to convert the high-voltage alternating current to unidirectional current supplied to the precipitator through a negative-potential high-voltage line, with the positive side grounded as previously explained.

For flexibility and safety the high-voltage connections to the precipitator are insulated cable rather than open bus work. To guard against injury to unauthorized persons attempting to enter the screened inclosure for the high-tension equipment, the doors are electrically interlocked to the switch controlling the source of power. Alarm attachments to the boiler room gage board warn of failure of equipment. Another feature worthy of mention is full protection against radio interference.

To determine the performance of the precipitators a long series of tests was run by the builder, the Research Corporation. To give a fair idea of the performance a summary of four of the tests made while one precipitator was serving a single boiler, is here presented. These tests were characterized by steady boiler operation, low combustible content of the ash, and good precipitator operation.

As to test procedure four inlet sampling points were selected in the vertical flue between the fan and the precipitator at a point just above the roof level and four points in the outlet just after the precipitator dampers. Each test consisted of two runs in each of which four simultaneous samples were taken in both the inlet and the outlet. Efficiencies were based on data obtained from the ash concentration at the sampling points, the concentrations being computed to grains of fly ash per cubic foot of gas at standard conditions (32 deg. F. and 29.92 in. of mercury). The concentrations were determined by the company's standard method, consisting of drawing a metered volume of gas at regularly measured conditions of temperature and pressure through a dried, weighed, paper-extraction thimble mounted in a steel holder inserted in the flue. After the test the thimble is redried and weighed, the increase in weight representing the amount of dust extracted. Gas volumes were computed from pitot tube readings taken at the inlet sampling point previous to each run and at the boiler rating of the run. For each measurement readings in seventy-two locations in the flue were taken.

Results appear in the accompanying table. It will be seen that dust concentrations in the inlet gas range from 2.05 to 2.50 grains per cubic foot, and at the outlet from 0.0318 to 0.176. In three of the tests the gas volumes approximated the specified capacity of the precipitator, that is, they were close to 165,000 cu.ft. per minute. Efficiencies ranged from 95.2 to 98.4 per cent. Approximate boiler outputs during these tests ranged from 342,000 to 356,000 lb. of steam per hour,

SUMMARY OF TESTS ON PRECIPITATOR SERVING SINGLE BOILER

Test No.	Grains per Cubic Foot: Inlet Conc.	Grains per Cubic Foot: Outlet Conc.	Efficiency, Per Cent	Gas Volume, C.F.M.	Approx. Gas Vol. per Duct C.F.M.	Gas Velocity Ft. per Sec.	Boiler Output, Lb. Steam per Hr.
1	2.05	0.0318	98.4	170,500	5,700	8.12	356,000
2	2.50	0.0885	96.4	164,000	5,500	7.81	343,000
3	2.31	0.11	95.2	163,500	5,500	7.78	342,000
4	2.29	0.176	92.3	198,000	6,600	9.43	415,000

corresponding to operation at 456 to 474 per cent nominal rating, if areas in the water walls and steaming economizer are included as active steam making surface.

When the steam output ran up to 415,000 lb. per hour, equivalent to 553 per cent rating, and the gas volume increased to 198,000 cu.ft. per minute, 20 per cent above the specified capacity of the precipitator, the efficiency dropped to 92.3 per cent. In this test the gas velocity figured 9.43 ft. per second, as compared to an average of 7.9 in the other three tests. The table shows that this factor as well as uniform gas distribution has an important bearing on the results.

General operating results seem to bear out the tests. Except at rare intervals there have been no evidences of smoke or dust from the stack. Even the light haze common to chimneys emitting fly ash, is missing. In the elimination of dust from flue gases, the results from this installation are considered as nearly perfect as the type of equipment used will permit.

For the information presented acknowledgment is made to Sargent and Lundy, Inc., Chicago, consulting engineers for the station who were responsible for the creation of the special duct arrangement. Tests results were obtained from the builder of the precipitators.

Air Conditioning for Low Humidity With Silica Gel

By J. WELLS and L. G. WADE

AN ECONOMIC STUDY of the cost of manufacturing telephone cable, and the value of improved voice transmission, indicated the desirability of maintaining relative humidity of 0.5 per cent in the cable storage oven for unsheathed telephone cables at the Baltimore plant of the Western Electric Company. This room, in which the cables are stored after being dried in vacuum ovens, is 277 ft. long, 50 ft. wide and 12 ft. high.

In addition to the problem of dehumidification, a considerable amount of heat must be removed from the storage oven. The largest amount of heat to be taken care of is that given up by the cables, which come from the driers into the storage oven at a temperature of 260 deg. It is necessary, with the ultimate capacity of the room, to remove approximately 14,000 B.t.u. per minute, but for short periods this may reach 17,500 B.t.u.

To obtain the low relative humidities required a silica gel dehumidifying system was found preferable to a refrigerating air-conditioning system, because it was less expensive and avoided certain difficult problems that would come up in connection with a refrigeration unit. The use of silica gel is based upon its moisture-absorbing capacity. This material is a colloidal-form of silicon dioxide, a hard glassy material with the appearance of clear quartz sand. In its colloidal form, however, it is extremely porous, and on this property depends its power of removing water vapor from air which passes over it. If heat is applied to saturated silica gel the moisture is driven out, and the gel again rendered capable of absorbing a like quantity of moisture.

The air-conditioning system consists of silica gel absorbers, activation furnace, air-circulating fans, air filters, coolers and control systems. In the operation of the system, which is entirely automatic, there are four simultaneous cycles: first-stage absorption, second-stage absorption, activation and cooling. All recirculated and fresh air is first cleaned by passing through continuous electrically operated filters to remove all dirt and soot, which is essential, as the drier openings release smoke to the storage room.

Since the silica gel beds pass through four cycles, each bed has four inlet dampers and four outlet dampers to connect it to ducts so that it can function as noted. The dampers are actuated by compressed-air pistons whose movement is controlled automatically through an electric time clock. The time clock drives a cam, which is designed for a definite interval determined by the length of time the absorber can function. At the specified intervals a mercury switch is closed by the action of the cam, which starts a small motor driving four cams that control the compressed-air valves.

In the absorption cycle approximately 10,300 c.f.m. of air from the storage oven is mixed with 2,600 c.f.m. of fresh air, as shown in the schematic diagram. The temperature of this air, which may be as high as 115 deg., must be lowered to a temperature not greater than 68 deg. before entering the first silica gel absorber. This is effected by passing it over seamless copper fin tubes, through which well water at 58 to 60 deg. is circulated. From this point the air enters a

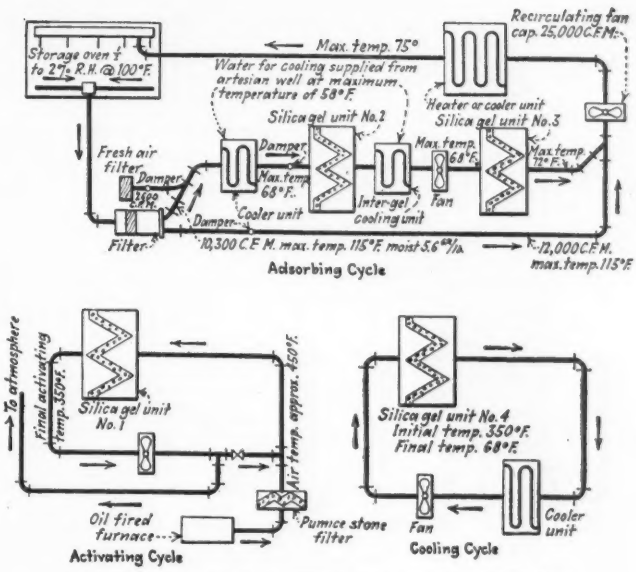


Diagram of the three cycles used in dehumidifying with silica gel

duct in which are located four dampers having access to each of the four absorbers, each of which contains about 3,000 lb. of silica gel. One of the absorber dampers is opened, and the air to be dehydrated passes into and through the absorber and out again on the opposite side to a common first absorber outlet duct. In the first absorber 95 to 97 per cent of the moisture is removed from the air. Another water cooler, between the first absorber and the second, removes the heat taken up by the air during the absorption process, and from the absorption fan and duct.

The air now passes through the second and final absorbers, and from this point is picked up by the main circulating fan, which distributes it into the supply duct in the storage oven. At the end of the cycle, when the first absorber has taken up moisture to a point approaching saturation of the gel bed, the dampers are changed automatically, the gel bed that was second in the absorption series becoming the first in the new cycle, and a freshly activated and cool bed becoming the second bed in the series.

The absorber taken out of the drying cycle is placed in the activation cycle. During the activation process about 4,500 c.f.m. of air is heated to a temperature of 400 to 450 deg. by passing it directly through an oil-fired furnace. The air-gas mixture from the furnace is passed through a filter bed of pumice stone to remove any uncombined carbon or foreign material, and then passed through the silica gel bed to a fan, which exhausts it to the outside air. The amount of heat generated in the furnace is controlled to give a temperature of 350 deg. in the gel bed at the end of the activation cycle.

The cooling cycle consists of lowering the activated bed from 350 deg. to a temperature not exceeding 68 deg. The air for this purpose is recirculated in a closed cycle through a cooler. Approximately 90 per cent of the cooling is effected by the waste water from the coolers on the gel inlet air and the coolers between the two absorbers on the absorption cycle.

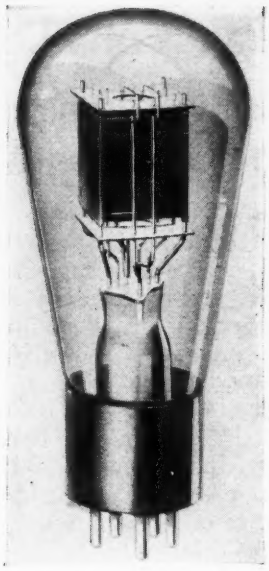
The silica gel system has capacity to remove a maximum of 4 lb. of water from 2,600 c.f.m. of fresh air and 0.6 lb. of water from 10,300 c.f.m. of recirculated air. The air entering the storage oven has a moisture content of 0.430 gr. per pound of dry air.

Photo-electric tube

ELECTRON TUBES

New Tools for

POWER ENGINEERS



Three-element vacuum tube

Power engineers are frequently confronted with the installation and operation of devices that include vacuum tubes, without having an intelligent understanding of their construction and how they function. This article, which is the first of two, explains the operation of photo-electric and three-element vacuum tubes and gives examples of how they are applied to problems of the power plant and industry. A second article will deal with other types of electronic tubes

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ELECTRON TUBES are new tools that have simplified many problems in the generation and application of power and have removed limitations encountered with conventional types of electrical and magnetic equipment. Hundreds of new uses already have been found for these tubes in the power generation and application fields alone and yet the possibilities of using them have only been scratched. Present applications include rectifying alternating current into direct current; speed control of motors; smoke-density measurements; water-turbidity detection; levelling elevators at hoistway landings; protection of passengers in hoistway doors; and many others.

Electron tubes are made in different types, such as photo-electric, vacuum tubes, thyratrons and grid-glow tubes. Photo-electric tubes are available in both the vacuum and gas-filled types. Tubes of the gas-filled type will pass higher currents than those of the vacuum type because of the phenomenon known as gas amplification. A photo-electric tube is of rather simple construction and contains only two elements, an anode and a cathode. The cathode consists of a curved metal plate sensitized with an alkali metal such as sodium, potassium, lithium, rubidium or caesium. The anode is in the form of a metal ring or grid and is so located in the tube that light passes through it before striking the cathode.

Fig. 1 shows an elementary photo-electric-tube direct-current circuit. The anode is given positive potential and the cathode negative by the battery, but under ordinary conditions no current will flow. If light is allowed to pass through the anode onto the cathode, electrons are released from the latter and are attracted to the former. In this way the space between the anode and cathode becomes a conductor and a current flows in the circuit. Removing the light causes the space between the anode and cathode to become an insulator and stops the current flow in the circuit. Varying the light intensity will cause the flow of current through the tubes to change almost in proportion to the amount of illumination reaching the cathode.

Current will flow only from the anode to the cathode. If the polarity of the tube is reversed, that is if the cathode, Fig. 1, is made positive and the anode negative, no current will flow in the circuit. From this characteristic it is seen that the tube may be used to rectify alternating current.

In Fig. 2 if the light is allowed to shine continuously on the cathode, current will flow in the circuit during the half of the alternating-current cycle that voltage is in a direction shown by the arrows, that is, in a direction to make the anode positive. During the half cycle when the voltage is reversed and tending to cause current to flow from the cathode to the anode no current will pass through the circuit. The result of such an operation would be a series of current impulses in the circuit as shown by the curves in Fig. 3. The space between the curves represents the periods when the direction of the voltage was from the cathode to the anode and no current was flowing in the circuit. By connecting two tubes in the circuit a continuous series of current impulses can be had as indicated by the curves Fig. 4, where each alternation is rectified.

By using photo-electric tubes of proper design they can be made to supply the initial impulse to produce an almost infinite number of actions. In addition to responding to light intensity photo-electric tubes are available that are sensitive to the color of light and may be used in devices for matching colors. The current that a photo-electric tube will pass is very small, being only a few hundred micro-amperes at the most and must be amplified through vacuum tubes before it can be used to

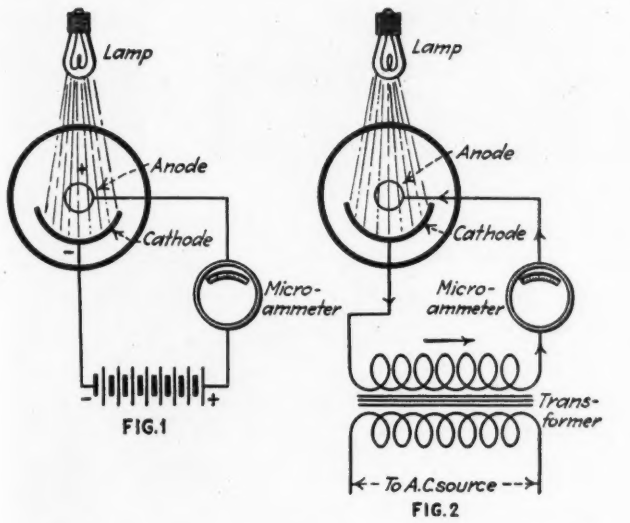
operate a relay. The magnitude of the current that can be passed through a photo-electric tube will depend upon the nature of the metal on the surface of the cathode, the color and intensity of the light, whether the tube is of the vacuum or gas-filled type and the potential applied to the anode. The potential used may vary from about 30 to 300 volts, but many of the tubes in use are designed for 90 volts.

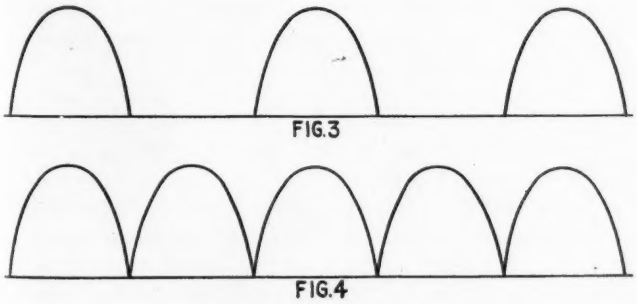
Ordinary three-element vacuum tubes such as used in radio work may be used to amplify the current of a photo-electric-tube circuit. The three-element vacuum tube consists of a filament made of tungsten, carbon or of tungsten coated with one of several metals, and is in the center of the tube. Next to the filament is the grid consisting of an open wire mesh of molybdenum and outside the grid is the plate frequently made of a sheet of nickel.

Fig. 5 shows the simple circuits of a two-element tube consisting of a plate and a filament. The filament is the part that makes the tube operative. It is heated by a battery to a temperature where negative electrons are given off into space. The plate is connected to the positive side of a battery and is therefore positively charged and attracts the negative electrons given off from the filament. In this way a current from the plate battery is conducted through the tube and may be considered as flowing from the + side of the battery through the milliammeter to the plate across the space between the plate and filament and to the — side of the battery.

The current flowing in the circuit will depend upon the voltage applied to the filament and to the plate, the distance between them and other factors. Control of the current through the tube may be had by placing a grid between the plate and filament and regulating the potential on it. A diagram of a simple three-element-tube circuit is shown in Fig. 6. If the grid is given a minus potential, it will oppose the flow of negative electrons from the filament to the plate and will reduce the flow of current through the tube. A minus potential on the grid of a few volts will be sufficient to reduce the plate current to zero. Then by reducing the grid's potential the current flow through the tube will increase. For example, in Fig. 6 by connecting the grid to the minus side of battery *C* the full voltage of the battery is applied between the filament and the grid. In other words the grid is at a minus potential equal to the voltage of the battery. Assume that this is just sufficient to reduce the plate current to zero. Then by moving contact *D* across the resistor *R* the minus potential on the grid will be reduced and the plate current increased. When *D* is connected to the positive side of battery *C* the grid potential will be zero and the current flow through the tube will be practically the same as if the grid were not present.

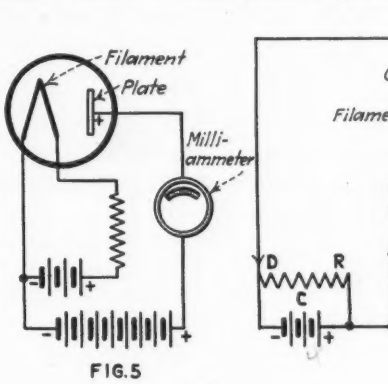
If the polarity of the grid is reversed, as by reversing the connections to battery *C*, the grid will be given a plus potential and will tend to assist the electrons passing from the filament to the plate and increase the current flow. Since the grid is physically closer to the filament than the plate a small negative potential on it will overcome a large positive potential on the plate. For the same reason a small positive potential on the grid will





FIGS 1 TO 4—
SIMPLIFIED PHOTO-ELECTRIC-TUBE CIRCUITS

Fig. 1—Photo-electric tube connected to a battery. Fig 2—Photo-electric tube connected as a rectifier. Fig. 3—The curves represent the current flow through the photo-electric tube, Fig. 2. Fig. 4—Two photo-electric tubes properly connected to a transformer would give a current represented by the curves



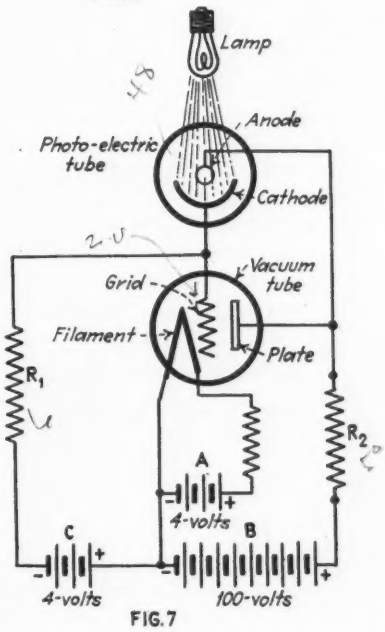


Fig. 5 — Simplified two-element vacuum-tube circuit

Fig. 6 — Simplified three-element vacuum-tube circuit

Fig. 7—Photo-electric tube connected to control a three-element vacuum tube

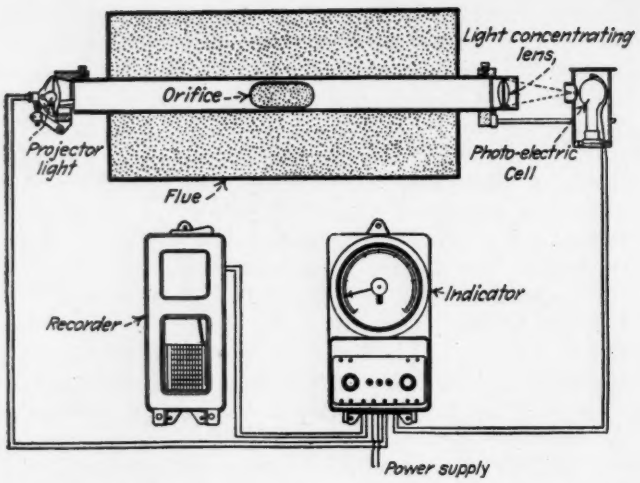


Fig. 8—Diagram of a photo-electric cell type smoke-density indicator and recorder

greatly accelerate the flow of electrons from the filament to the plate. From the foregoing it is evident that by controlling the potential on the grid the plate current can be regulated from zero up to the capacity of the tube.

A photo-electric tube may be used to control the potential on the grid of a vacuum tube as in Fig. 7. This connection is essentially the same as Fig. 6 except a photo-electric tube has been added. When the photo cell is not excited by light shining into it, the potential of battery C is applied between the grid and the filament. Since the negative side of the battery is connected to the grid its potential is 4 volts minus. That is, a current tends to flow from the + side of the battery C by way of the filament to the grid and through resistance R_1 to the — side of the battery. The negative potential of 4 volts on the grid prevents electrons passing from the filament to the plate and no current will flow through resistance R_2.

When light is allowed to shine into the photo-electric tube it becomes a conductor and if the circuit is properly designed the grid potential can be reduced to zero or made positive and current will flow from the plate to the filament from battery C. For example, assume that when a stable condition has been attained in the circuit after the photo cell is excited that there is 50 volts drop across resistance R_2, and 48 volts drop across the photo cell. This would leave 6 volts potential across resistance R_1, or a total of $50 + 48 + 6 = 104$ volts. the voltages of batteries B and C being in series. The 6 volts potential across R_1 is also applied to the grid,

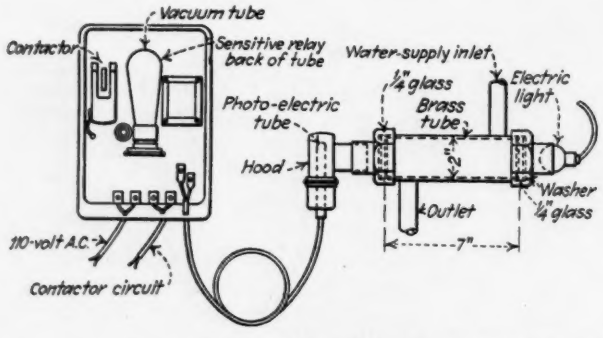
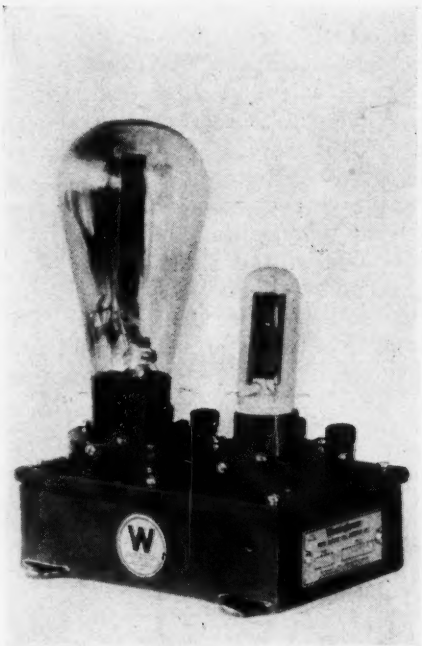


Fig. 9—Photo-electric tube used to indicate coloring matter in water

but this is reduced by 4 volts from battery C, consequently the grid has a plus potential of $6 - 4 = 2$ volts. In other words the potential of the grid is changed from 4 volts negative to 2 volts positive by the action of the photo cell.

A relay coil could be substituted for resistance R_2 and the relay be caused to function simply by cutting light out from or admitting it to the photo cell. For example, the light could be placed on one side of an elevator hoistway door with the photo cell on the other and a relay coil connected in as R_2 with normally open contacts in series with the control circuit for the doors. As long as passengers are passing in or out of the doors they intercept the light on the photo-electric tube and the relay contacts remain open, consequently the doors will



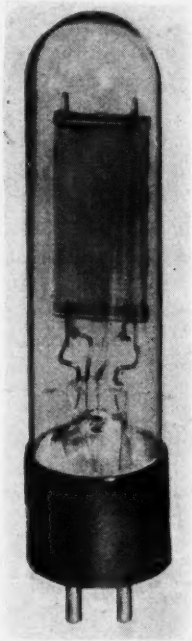


Fig. 10 (Left)—Photo-electric tube and amplifier unit

Fig. 11 (Right) Modern type selenium cell inclosed in a vacuum tube

not close even if the operator moves the control to the on position.

As the elevator cannot start until the doors close, the photo cell not only prevents the hoistway doors from closing if a passenger is in their line of motion, but it indirectly prevents the elevator from starting. This application of the photo-electric tube is an excellent example of applying it as a safety device.

The combination Fig. 7, could be used to initiate operation instead of preventing it. Objects to be counted could be allowed to pass between the light and photo-electric tube and interrupt the light on the tube and in so doing operate a counting device. Instead of operating a counting device it might bring into action an unloading device on a conveyor. In this case when the load on the conveyor reaches a predetermined position it is caused to interrupt the light to the photo-electric tube to bring the unloading device into action.

Instead of using the photo cell to stop the flow of current through the vacuum tube it may be used to vary the current in the plate circuit by varying the light's

intensity to the photo cell. A smoke recorder is an example of this application. By arranging the light and the photo cell so that the stack gases pass between them, the light on the photo cell will be varied according to the density of smoke in the gases going to the stack. Changing the amount of light on the photo-electric tube will change the value of the current through it and consequently vary the voltage on the vacuum tube's grid and change the current flow. Resistance R_2 can be the coil of an indicating or recording instrument and by properly calibrating the instrument it can be made to show the smoke density. Fig. 8 shows the general arrangement of a smoke-density recorder and indicator built on the principle described in Fig. 7. The locations of the projecting light and the photo-electric cell are clearly indicated. In this equipment the amplifying vacuum-tube system is in the base of the indicator. Fig. 10 is a photo-electric cell and amplifier unit that may be used for smoke-density measurements, turning on and off artificial lights according to the intensity of natural light and may be used for numerous other applications.

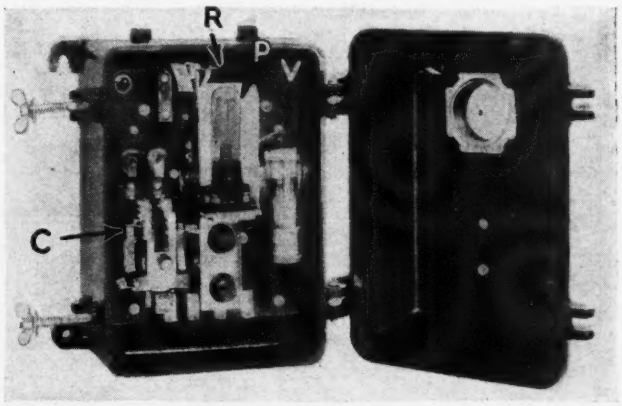


Fig. 12—Outdoor light-control unit that responds to varying intensities of natural light. This unit contains a photo-electric cell *P*, a vacuum tube *V* a relay *R* and a main contactor *C*

Fig. 13—Instrument for determining illumination intensities

Water-Turbidity Indicator

Fig. 9 shows another interesting application of the principle described in Fig. 7, but instead of smoke density varying the current in the photo-cell and vacuum-tube circuit, turbidity in water is the medium. The water supply for the City of Denver, Colo. is from mountain streams and in general is clear. During high-water periods its turbidity is likely to be high. It is necessary that a close watch be kept on the water for changes in turbidity so that it may be properly treated. To release the operator of this responsibility a photo-electric relay was devised like that shown in the figure. The detecting device is a piece of 2-in. brass tube 7 in. long. Each end of the tube is closed with a piece of plate glass held in place by a cap that supports an electric light at one end of the tube and, at the other end, the photo-electric cell is mounted.

Inlet and outlet water connections are made to the tube and a sample of the water flows through it continuously. A change in the color of the water affects the amount of light on the photo cell which in turn changes the current through the vacuum tube. The device is so adjusted that when water of a certain turbidity passes through the brass tube the relay closes and sounds a gong. When an influx of muddy water has been detected, the device can be set by throwing a reverse switch to sound a warning when the water clears to normal again. It has been found that the photo-electric tube is more accurate than the human eye in giving warning of a change in turbidity.

The foregoing gives an indication of some of the many uses to which photo-electric tubes may be put. As previously mentioned, their field of application is practically unlimited. The next article will give other applications in connection with thyratron and grid-glow tubes.

Other Light-Sensitive Devices

From the foregoing it should not be assumed that photo-electric tubes are the only light sensitive devices. There are several other among which are metallic plates the surfaces of which have been treated in such a way as to make them sensitive to light. Many of these combinations have been developed but only a few have proved commercially practicable. When light is allowed to shine on these plates a voltage is produced. In at least one type the voltage is sufficient to cause a current of milliampere proportions to flow and the device will remain stable almost indefinitely.

An instrument for determining the intensity of illumination, utilizing sensitized metallic plates (photronic cells as they are called) is shown in Fig. 13. It consists of an indicating instrument and a light target assembled in a portable case. The light target is on the end of a flexible cord so that it may be placed in any position. This target, or searching unit, has two photronic cell units which convert light energy directly into electrical energy without the use of batteries or other auxiliary voltage. The output from the photronic cell unit is sufficient to allow the use of a substantial instrument calibrated to indicate in foot-candles the illumination admitted to the light-cell unit. This type of cell may be used for a wide variety of applications where a device sensitive to light is required.

Photo-voltaic cells or batteries are available that produce a change in current flow with changes of illumination. These cells somewhat resemble the ordinary primary battery dry cell except that a glass container is used so that light may enter the cells. They are made in both the dry and wet forms. Another form of light cell is the familiar selenium type, the resistance of the selenium element changing in the presence of light. In its latest form, Fig. 11, this type of cell is inclosed in a vacuum tube similar to a photo-electric cell.

How to Obtain Flexibility in Pipe Lines

By E. T. COPE and E. A. WERT
The Detroit Edison Company

The effect of short radii and tangent lengths on the flexibility of pipe lines is clearly demonstrated, and corrugated pipe and creased bends are discussed. This article was prompted by three articles on creased bends published recently in Power[1]

ONE way of providing flexibility in a steam line is by expansion U bends to care for thrusts and moments produced by elongation due to temperature change. This method is applicable where the piping lies in a straight line or where a sufficient length of straight pipe can be employed to permit its use. In general, modern power stations, both industrial and central, are not so favorably arranged that the pipe may be run straight for considerable distances. On the other hand, the use of straight lengths of pipe subjected to bending by the introduction of change in direction of the steam main provides the simplest and most effective means of caring for the thrusts and moment resulting from elongation of the pipe due to temperature change.

This article aims to show the following:

1. The effect of the introduction of tangent lengths subjected to bending in several cases of smooth piping in one plane. This will show the extent of the benefit to be derived by the use of directional change in steam piping design.

2. The effect of change in radius of curvature on the forces, moments and stresses in a simple, two-directioned pipe line having a 90-degree bend and anchored at both ends.

3. The effect of change in radius of curvature on the forces, moments and stresses in an expansion U bend made of smooth pipe in a steam line.

4. The effect of corrugated tangents on forces, moments and stresses in a simple two-directioned steam pipe.

5. The benefits derived by the use of a corrugated U bend, such as either of those which connect the high-pressure and low-pressure cylinders of the 1,000 deg. F. steam turbine at Delray No. 3 power plant[2]. This will be carried out by showing the values of thrusts and stresses produced when the pipe is heated to 600 deg. F. Similar values will be given for a smooth pipe U bend of the same dimensions as the corrugated pipe, and for a smooth pipe U bend in which the stress will be held within working values.

6. The results obtained by the use of a corrugated tangent in compression.

The results of calculations rather that the calculations themselves are shown. Those wishing to perform the calculations are referred to any recent text on applied mechanics and to Chapter VII, Second Edition, Piping Handbook, by Walker and Crocker, where the details of the method are shown.

Consider first a cantilever beam such as that shown in Fig. 1, Case I (a). This is made of standard weight 10-in. smooth steel pipe 200 in. long. The beam is fixed

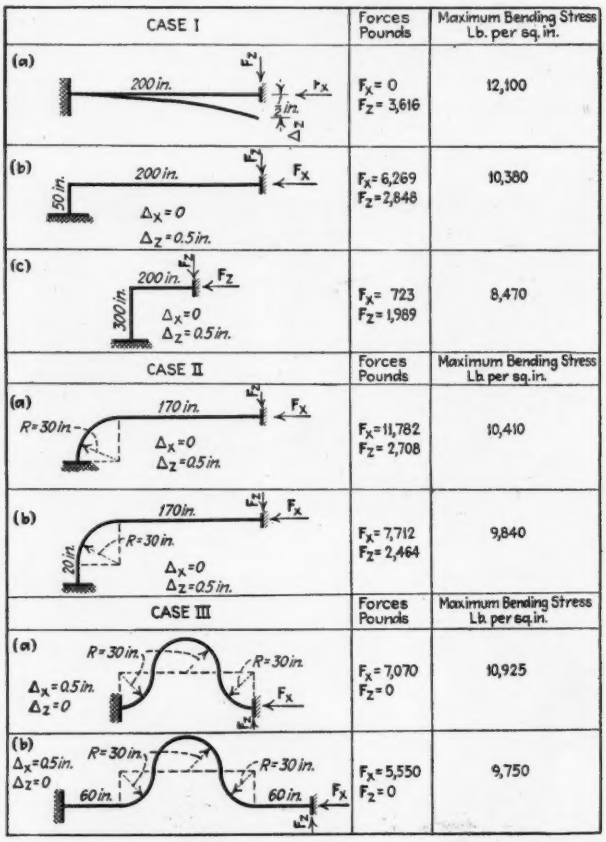


Fig. 1—The flexibility obtainable in a piping system by change of direction is illustrated by these examples

[1] *Power*, June 2, 1931, "Creased Pipe Bends Offer Great Flexibility," W. Paul; *Power*, Oct. 20, 1931, "Flexibility of Plain and Creased Pipe Bends," A. M. Houser and S. Hirschberg; *Power*, Dec. 22, 1931, Discussion, P. H. Gallo.

[2] See *Power*, October 27, 1931, for a description of this turbine by R. M. Van Duzer, Jr.

rigidly at its left-hand end, and its right-hand end is constrained to move only in the direction of the transverse force F_z. This force is just sufficient to deflect the end of the beam 0.5 in. The values of the forces acting and maximum bending stress are also shown.

In Fig. 1, Case I (b), a 50-in. tangent made of the same weight and size of pipe is introduced between the left-hand end of the 200-in. beam and the anchor point. The right-hand end of the 200-in. cantilever is constrained to move only in the direction of the force F_z. This force is of such a value that the right-hand end of the beam is deflected 0.5 in. The values of the forces and the maximum stress are shown. It is to be noted that, while the transverse force necessary to deflect the beam (0.5 in.) is materially less than in Case I (a), there is produced a large axial thrust due to the restraint.

Fig. 1, Case I (c), shows the effect of increasing to 300 in. the length of the tangent introduced between the anchor point and the left-hand end of the 200-in. beam. The right-hand end of the 200-in. beam is constrained to move only in the direction of the transverse force F_z. This force is just enough to produce 0.5-in. deflection at the point of its application. In this arrangement the axial restraining force is greatly reduced as is also the transverse force. The maximum stress is also greatly reduced.

Case II (a) shows a 170-in. tangent made of standard weight 10-in. steel pipe. To the left-hand end is attached a quarter bend having a radius equal to three pipe diameters. The lower end of this quarter bend is rigidly held. The right-hand end of the tangent is constrained to move only in the direction of the force F_z. The value of F_z is just enough to deflect the end of the tangent 0.5 in. There is a reactive force acting to hold the end of the tangent fixed in an axial direction. In Case II (b) a tangent 20 in. long is introduced between the end of the quarter bend and the anchor point, conditions of loading, deflection and restraint being kept the same. The reactions of these two structures to the given deflection in the matter of forces and stresses are shown.

The effect of the addition of tangents to the ends of an expansion U bend when loaded in an axial direction is shown in Fig. 1, Case III. Case III (a) shows an expansion U bend made up of four equal quarter bends of standard weight 10-in. pipe. The U bend is anchored at its left-hand end. Its right-hand end is constrained to move only in an axial direction. An axial force F_x just large enough to deflect the right-hand end 0.5 in. is applied. In Case III (b) a tangent sixty inches long made of standard 10-in. steel pipe is attached to each end of the U bend. The left-hand end of the structure is anchored and the right-hand end is constrained to move in an axial direction. The deflection produced is 0.5 in. It is to be noted that the force, F_x, necessary to produce the deflection is approximately 21 per cent less in Case III (b) than in Case III (a). The maximum stress in Case III (b) is approximately 11 per cent less than in Case III (a).

Bends of Different Radii

Given two fixed pipe connections at right angles to each other to be connected by standard 10-in. steel pipe. Only one quarter bend is to be used. The temperature rise due to introduction of steam or other hot fluid is assumed to be enough to produce changes of length of 0.2 in. in the horizontal tangents and 0.24 in. in the vertical tangents of Fig. 2. The effect on thrusts and stresses is shown. In this group of structures *a* shows the most favorable stress values.

Change of Radius of Curvature in an Expansion U Bend

Fig. 3 shows the effect of change of radius of the quarter bends of an expansion U bend having both ends anchored. The distance between the anchored ends is 300 in. The effect of change of radius of the quarter

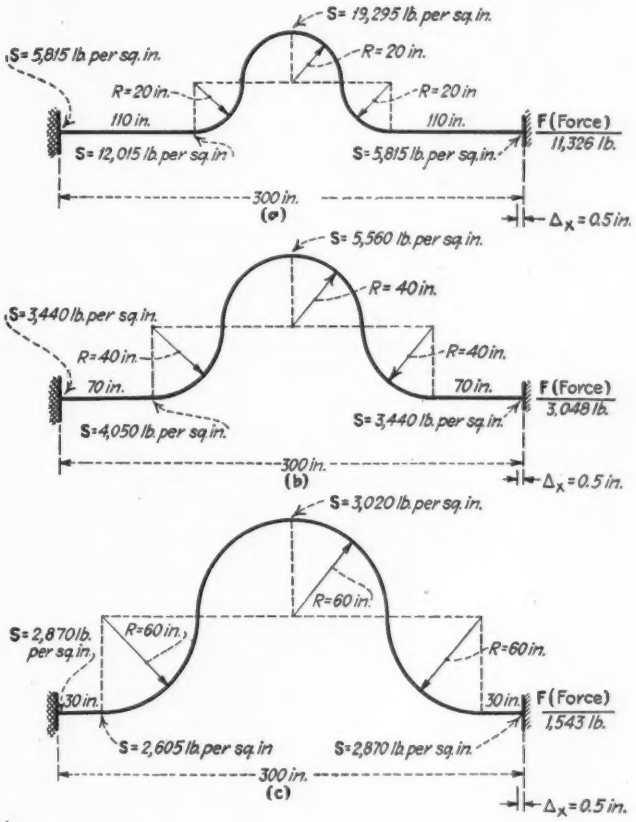


Fig. 3—The effect of changes in radius of curvature on flexibility of a U expansion bend without introducing tangent lengths

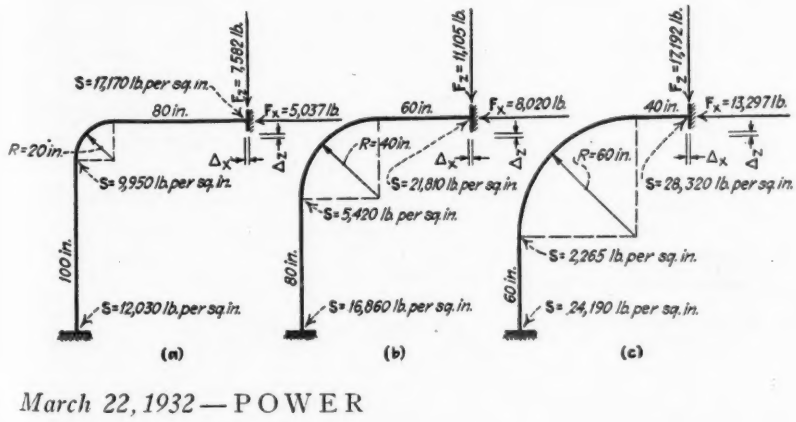


Fig. 2—The effect on stresses and reaction forces of changes in radius of curvature in 90 deg. pipe bends

bends is to change the overall height of the structure and to change lengths of the two equal horizontal tangents. In this kind of structure the thrusts and the maximum stress decrease with increase in radius of the quarter bends.

Fig. 4 shows an expansion U bend having fixed height as well as fixed length. This bend is made up of standard weight 10-in. steel pipe. The ends are anchored and it is assumed that there is an elongation of 3 in. The thrusts and stress are shown in Table I.

TABLE I — EFFECT OF CHANGE IN RADIUS ON THRUST AND STRESS IN A U BEND OF FIXED HEIGHT

		Fig. 4 (*a*)	Fig. 4 (*b*)	Fig. 4 (*c*)
Thrust — lb. at	h	2,342	3,936	3,790
Stresses — lb. per sq.in. at	d	5,875	7,310	9,325
	e	12,145	8,610	8,465
	f	6,655	8,400	10,955
	g	13,755	9,895	9,943
	h	5,875	7,310	9,325

In this arrangement, while Fig. 4 (a) shows the lowest value of thrust at the anchor point, Fig. 4 (b) shows a more uniform stress distribution.

The Use of Corrugated Tangents

The foregoing discussion of the effect of tangent members in bending has been applied to smooth pipe only. If, now, one or the other of the tangents be considered made of corrugated pipe, the forces and stresses will be much different. Fig. 5 (a) shows a steam line in one plane. This is made up of 12-in. standard steel pipe. The quarter bend, though shown creased, might just as well have been a short radius smooth bend of the same dimensions. In the calculations, the creased bend was assumed to have the same flexibility as a short radius bend made of smooth pipe. The basis for this assumption was the test and calculated results reported in the author's paper on "Load Deflection Relations for Large, Plain, Corrugated and Creased Pipe Bends," which was presented before the June, 1931, meeting of the American Society of Mechanical Engineers at Hartford, Connecticut. The ends of this pipe structure are assumed to be rigidly fastened. This is the assumption made in the calculations applied to pipes subjected to forces and moments resulting from thermal expansion. The piping was assumed to have been assembled at 60 deg. F. and to be operating at 700 deg. F. This temperature change

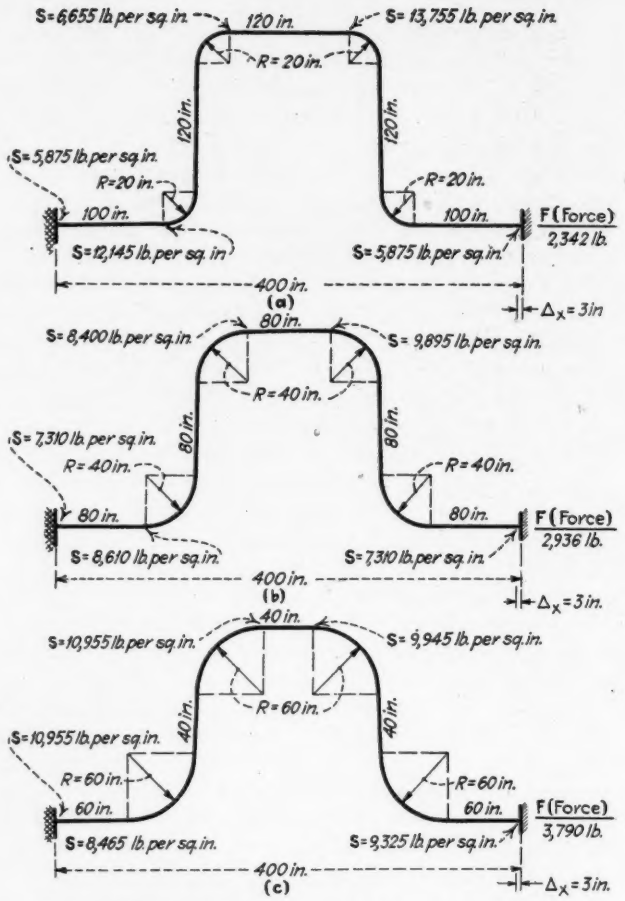


Fig. 4—Effect of introducing tangent lengths on flexibility of expansion U bends

would produce a linear expansion of 5.636 inches per 100 feet of pipe.

In Fig. 5 (b) the 19-ft. tangent is assumed to be made of corrugated steel pipe. The flexibility of the corrugated tangent is taken to be five times that of the 19-ft. smooth pipe tangent. The use of a relative flexibility factor of five for a corrugated tangent is also based on the tests reported in the authors' paper noted above.

In Fig. 5 (c) the 15-ft. tangent is replaced by a corrugated tangent of the same length.

All three of these pipe assemblies were assumed to be

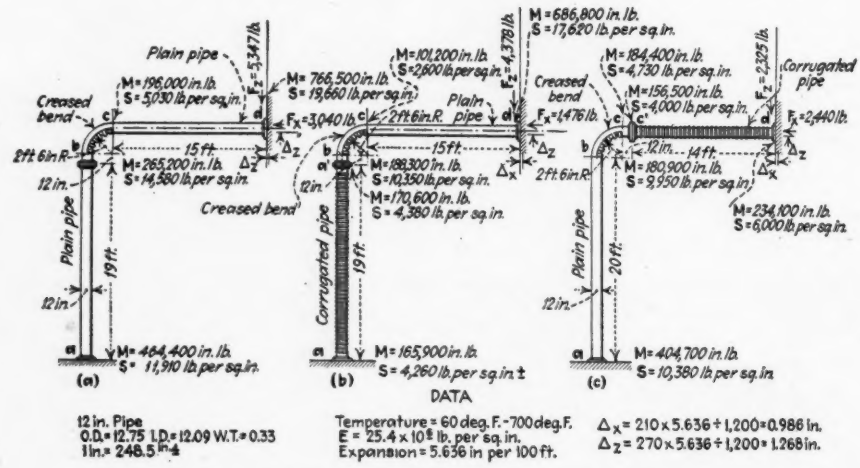

Plain pipe
Creased bend
M = 196,000 in. lb.
S = 5,030 lb. per sq. in.
Fz = 5,347 lb.
M = 766,500 in. lb.
S = 13,660 lb. per sq. in.
Fx = 3,040 lb.
2 ft 6 in. R
15 ft.
12 in.
M = 265,200 in. lb.
S = 14,580 lb. per sq. in.
Creased bend
Plain pipe
19 ft.
12 in.
M = 464,400 in. lb.
S = 11,910 lb. per sq. in.
(a)
M = 101,200 in. lb.
S = 2,600 lb. per sq. in.
Fz = 4,378 lb.
Plain pipe
Fx = 4,476 lb.
2 ft 6 in. R
15 ft.
M = 188,300 in. lb.
S = 10,350 lb. per sq. in.
M = 170,600 in. lb.
S = 4,380 lb. per sq. in.
Corrugated pipe
19 ft.
M = 165,900 in. lb.
S = 4,260 lb. per sq. in. ±
(b)
M = 686,800 in. lb.
S = 17,620 lb. per sq. in.
M = 184,400 in. lb.
S = 4,730 lb. per sq. in.
Creased bend
M = 156,500 in. lb.
S = 4,000 lb. per sq. in.
Fx = 4,476 lb.
Fz = 2,325 lb.
Corrugated pipe
Fx = 2,440 lb.
12 in.
14 ft.
2 ft 6 in. R
M = 180,900 in. lb.
S = 9,950 lb. per sq. in.
M = 234,100 in. lb.
S = 6,000 lb. per sq. in.
Plain pipe
20 ft.
12 in.
M = 404,700 in. lb.
S = 10,380 lb. per sq. in.
(c)
DATA
12 in. Pipe
O.D. = 12.75 I.D. = 12.09 W.T. = 0.33
I in. = 248.5 in.4
Temperature = 60 deg. F. - 700 deg. F.
E = 25.4 x 10⁶ lb. per sq. in.
Expansion = 5.636 in per 100 ft.
Δx = 210 x 5.636 ÷ 1,200 = 0.986 in.
Δz = 270 x 5.636 ÷ 1,200 = 1.268 in.

Fig. 5—Effect of creased bends and corrugated tangents on flexibility

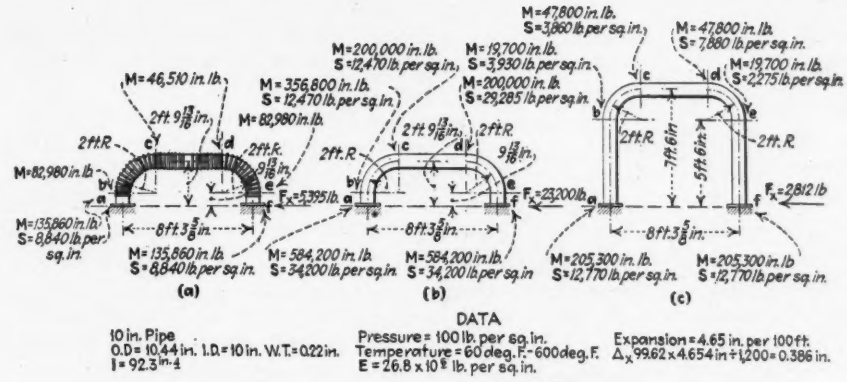


Fig. 6—A plain U bend of the dimensions shown at C is necessary to limit the stresses to a safe value when exposed to the temperature change for which the corrugated U bend at a was designed

made of the same kind of steel, to be operating at the same temperature and to be fixed at each end flange. Calculations were carried out, using the method described in Chapter VII of the Piping Handbook. The values of forces, moments and maximum stress are shown in Table II.

TABLE II — EFFECT OF CORRUGATED PIPE ON THRUST AND STRESS IN PIPE BENDS

		Fig. 5 (*a*)	Fig. 5 (*b*)	Fig. 5 (*c*)
Thrust *Fx* in lb.		3,040	1,476	2,440
Thrust *Fz* in lb.		5,347	4,378	2,325
Max. bending moment — in. lb. at	a	464,400	165,000	404,700
	a′	.....	170,600	.....
	b	265,200	188,300	180,900
	c	196,000	101,200	184,400
	c′	.....	.....	156,500
	d	766,500	686,800	234,100
Max. stress lb. per sq.in. at	a	11,910	4,260	10,380
	a′	.....	4,380	.....
	b	14,580	10,350	9,950
	c	5,030	2,600	4,730
	c′	.....	.....	4,000
	d	19,660	17,620	6,000

Obviously the assembly in Fig. 5 (c) shows the most nearly equal reactions at the fixed flanges and the smallest variation in the maximum bending moment and of the maximum stress. It is the only assembly in which the stress at all points is below the allowable working maximum.

Corrugated Vs. Smooth Pipe U Bend

The corrugated pipe, both tangents and bends, have been used in Europe for several years. Only recently have they been employed in actual installations in this country. The 1,000 deg. F. steam turbine now operating in Delray No. 3 Power Plant has two corrugated pipe cross-overs between the exhaust end of the high-pressure cylinder and the inlet end of the low-pressure cylinder. Figure 6 (a) shows one of these bends. Tests conducted by the authors showed this bend to be 4.3 times as flexible as a smooth pipe bend of the same major dimensions. This means that with a given force applied in the plane of the flanges and in the plane of the pipe bend, the deflection was 4.3 times as great as the calculated deflection for a smooth pipe bend of the same dimensions such as is shown in Fig. 6 (b). From these results it was concluded that the forces and moments at the various points indicated on Figure 6 (a) were equal to those at the corresponding points on Figure 6 (b) divided by 4.3. The grapho-analytical method was used in determining the values of forces and moments. The pipe bend was assumed to have been installed at 60 deg. F. and to be operating at 600 deg. F. The value of *E* for steel at 600 deg. F. was used. Fig. 6 shows the forces, moments and stresses at the various points indicated.

It is not at present possible to calculate the stress in a corrugated pipe since there has not been published any method by which stress may be definitely determined. Obviously the force set up at *f* and the stresses at the various points in the smooth pipe bend, Fig. 6 (b), could not be tolerated.

Fig. 6 (c) shows a smooth pipe bend to replace Fig. 6 (a). This bend is so proportioned that the maximum stress due to bending when installed and operating under the same temperature condition as the corrugated bend Fig. 6 (a) is within allowable working values. The value of the force at *f* and the moments and stresses are shown. The height of this bend, it will be noted, is 7 ft. 6 in., whereas that of the corrugated bend is 2 ft. $9\frac{13}{16}$ in.

Corrugated Pipes in Axial Loading

Some tests to determine the value of pressure drop of steam flowing through a corrugated bend were conducted at Marysville Power Plant. The corrugated bend in a 14-in. pipe was a part of the main superheated steam line to a 50,000-kw. turbine. The pressure drop through a corrugated bend having a radius of curvature of 3 ft. 6 in. was found to be approximately twice that through a 14-in. smooth pipe bend having a radius of curvature of 6 ft. 9 in., when the steam velocity was 13,000 ft. per min.

When it was determined by tests that the corrugated pipe possesses such superior flexibility characteristics, its use in axial loading to care for elongation of piping due to temperature change was suggested. Tests were made on two corrugated tangents to determine their deflection characteristics in axial loading. One of these was a 14-in., 400-lb., A.S.A. seamless steel corrugated pipe. The other was the corrugated section of Fig. 6 (a). It was found that the corrugated tangents tested were approximately six times as flexible in tension as smooth pipe tangents of the same diameter and wall thickness. It is easily shown that even this amount of flexibility cannot care for the elongation produced by temperature change, unless a very large restraining force is applied.

The more flexible of the two tangents tested shows an elongation of 0.005 in. in 19.47 in. when an axial load of 9,000 lb. was applied. It was assumed that the value of change of length would have been the same if the pipe had been subjected to an axial compressive load. If the increase in length due to thermal expansion is taken up by the decrease in length due to an axial compressive load, it is possible to write an equation between elongation due to heating and shortening due to compression with the restraining force the unknown quantity. The thermal expansion of mild steel per unit of length is, according to Holborn and Day, equal to

$$0.006212\left(\frac{t-32}{1{,}000}\right)+0.001623\left(\frac{t-32}{1{,}000}\right)^2$$

where t is the temperature of the steel in degrees Fahrenheit. If the temperature of the pipe was 500 deg. F., the following equation using the data furnished above may be written

$$19.47\times\frac{3.85}{1{,}200}=\frac{0.005}{9{,}000}P$$

where P is the axial restraining force necessary to hold the pipe anchored at its ends. Solving the above equation for P gives a value of 104,550 lb. assuming no bending in the pipe. This means that a straight run of this corrugated pipe of any length operating at 500 deg. F. would produce at its ends an axial thrust of 104,550 lb. if no axial movement were allowed. Such an excessive thrust obviously could not be tolerated. It, therefore, must be concluded that expansion due to temperature change will still have to be provided for in an expansion joint or bend, a loop or other directional change.

Conclusions

1. The design of a steam pipe to care for forces and moments resulting from elongation due to temperature change is not different in principle from the design of any other structure. The values of forces must be determined and the points of maximum moment must be located and their values calculated. From these values the stresses in the pipe members may be calculated. The thing of first importance is to so proportion and design the piping layout that the maximum stress is within allowable limits and that excessive bending moments do not occur at a flanged joint or at a weld, where welded pipe is used.

2. Sweeping generalizations as to the use of shapes and forms of expansion absorbing members is to be discouraged. A thorough study of the item in Conclusion 1 should dictate the kind and form of member to be used. Each piping layout had best be treated as an individual and a thorough study made of its stress and force characteristics.

3. The use of tangents subjected to bending to care for elongation results in a simple and effective form of design. If the pipe layout requires short radius turns, because of restricted space, the special shapes are to be recommended. The creased or corrugated bend may be used when piping without welds is demanded. The short radius bend is to be recommended in cases where welded pipe is endorsed. The authors have made no comment regarding the use of welded pipe. The art of welding is improving so rapidly that any statement of practice today would be out of date in a relatively short time.

Where large pipes have to be fitted into close quarters and considerable expansion has to be provided for, the corrugated tangent and the corrugated bend will be found to offer great advantage. Pressure drop values chargeable to corrugated pipe in such cases should be considered in the design.

The science of piping design has been quite definitely established. It remains for the designer of piping to make use of the tools at hand in the same manner as the designer of any other kind of structure.

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Maintaining the Quality Of Turbine Oil

By C. R. BROWN
Superintendent of Electric Production
Sioux City Gas & Electric Co.

and J. WILLARD PETERSON
Lubrication Engineer

JUST how much acidity a turbine oil should show after a period of service is debatable as also is the effect of centrifuging upon the acid content. For this reason a brief history of turbine lubrication at the Bix Sioux plant of the Sioux City Gas & Electric Company may be of interest to power plant executives and operating engineers of other steam turbine plants.

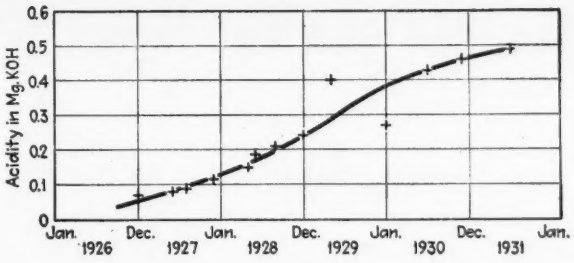
Two 10,000-kw. steam turbines using 350-lb. steam pressure at 125 deg. F. superheat were installed in 1925. In June, 1926, the two turbines and the reserve tank were filled with a total of 45 bbl. of fresh turbine oil. It was the practice during the first three years of operation to drain the oil from the turbines every 30 days, allow it to settle for 15 days, and then purify it in an oil centrifuge. The oil reservoir that formed part of the turbine was always cleaned before the reclaimed oil from the reserve tank was pumped into the system.

In 1929 it was noticed that the acidity of the oil had increased somewhat, so it was decided to give the oil a continuous bypass treatment and also a batch treatment every two months. In 1930 the practice was changed to the extent of giving the oil a batch treatment at the end of every 2,000 turbine-hours rather than after each two months of elapsed time. The three batches of oil were rotated, so as to use all the oil about the same number of hours. This resulted in the three batches of oil changing in acidity and demulsibility to the same degree. Tests made of samples from the three separate batches showed the change to be uniform.

It is the practice to obtain samples from the turbines at various intervals in order to keep an accurate check on the change that is taking place in the oil from year to year. The three original batches of oil, minus evaporation losses, have been in use for five and one-half years. During this time the daily turbine-hours have varied from 0 to 24 hr. The daily turbine-hours will average about fifteen for each turbine. The acidity values of the samples obtained during the five and one-half years were:

Date	KOH Mg.
December, 1926	0.07
May, 1927	0.08
July, 1927	0.09
November, 1927	0.12
April, 1928	0.15
May, 1928	0.19
August, 1928	0.21
December, 1928	0.24
April, 1929	0.40
December, 1929	0.27
June, 1930	0.43
October, 1930	0.46
July, 1931	0.49

The acidity is measured in terms of the amount of potassium hydroxide (KOH) in milligrams needed to neutralize a gram of oil. To make the test accurately weigh 100 grams of the oil into a flask, add a solution of 25 c.c. of distilled water and 25 c.c. of 95 per cent alcohol which has been neutralized with weak caustic soda, and heat to the boiling point. Agitate the flask thoroughly in order



Increase in acidity of turbine oil

to dissolve the free fatty acids as completely as possible. Titrate while hot with aqueous tenth-normal alkali, free from carbonate, using phenolphthalein, alkali blue, or tumeric as an indicator. Agitate thoroughly after each addition of alkali.

A study of the figures in the tabulation will show that there was a gradual increase in values except in the December, 1929, sample. The continuous bypass method of filtering was adopted after April, 1929, but this change would not be expected to have caused so large a drop in acidity.

The demulsibility value showed too great variation to be of any comparative value. This variation was probably due to the fact that some samples were taken directly after a batch treatment while other samples were taken previous to the time for a batch treatment. A sample of residue taken from the bowl of the separator was analyzed and found to contain 40 per cent iron soap and other solids, 20 per cent water and 40 per cent oil.

Though there has been a gradual increase in acidity, there has been no noticeable increase in the amount of sludge found in the bottom of the turbine oil reservoirs when the turbines are cleaned. Neither has there been any trouble from deposits in the oil lines.

We do not believe the acidity development which is allowable in a turbine can be stated with any great degree of precision. These mineral acids attack metals slowly, so that an oil of rather high acidity can be used for a long time without corrosion. However, it should be remembered that an increase in acidity usually goes hand in hand with an increase in rate of sludge formation. For this reason it is probably desirable to change oil when the acidity reaches a value of 0.6 to 0.8 mg. of potassium hydroxide.

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A New Protected Metal

ACCORDING to a recent research report by Dr. A. W. Coffman, a new protected metal called "Robertson-Bonded Metal" (R-B-M) has been carried through the laboratory stages of development at Mellon Institute of Industrial Research, Pittsburgh, Pa.

Robertson-Bonded Metal is the result of extensive research that has led to the production of a laminated metal-felt material in which felted materials are cemented to steel with heat and pressure, utilizing metals as adhesives. The composite laminated material, the outer surfaces of which are suitable felts, is then saturated with any desired saturant chosen with reference to the corrosive condition to which the metal is to be exposed.

Owing to the fact that it is possible to choose between a number of felts and felt saturants to stand against various corrosive conditions, this new protected metal promises flexibility in providing corrosion resistance. The ductile nature of the metal bond between felt and steel makes it possible to subject this material to forming operations such as shearing, bending, corrugating, rolling and mild drawing without destroying adhesion between felt and steel.

By selecting asbestos felt together with fireproof saturant a fireproof material results, while an increased insulating value over that of bare metal is obtained with any combination of felt and saturants.

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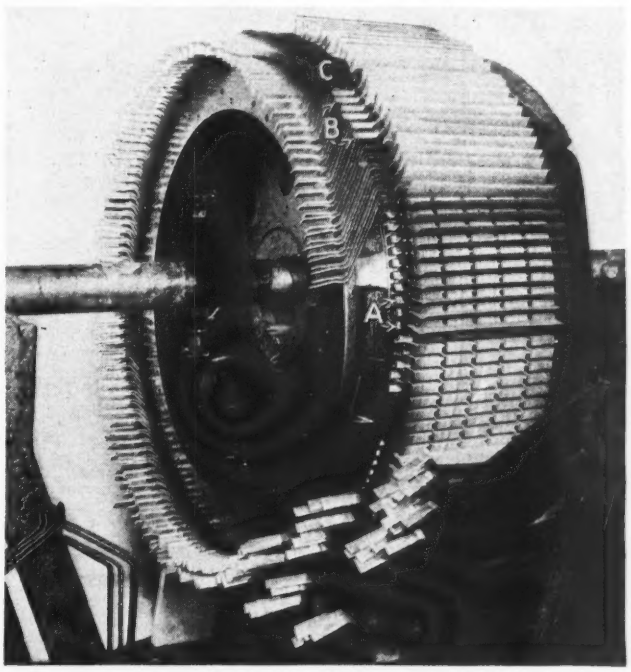
Insulation Details That Prevent Winding Failures

By A. C. ROE

THERE ARE in use many motors having wound rotors of the semi-closed slot wave-wound type with single-turn open-end strap-copper coils having two or more single coils or conductors per slot, as in the figure. The rotors require special attention when the coils are put in place to insure a finished winding free from weak spots in the insulation. For example, it is necessary that an insulating strip be placed in the bottom of all slots as at *A* before the bottom sides of the coils are put into the slots, to cushion the straps and prevent grounds. These insulation strips should project well beyond the core and winding insulation cells, as shown.

A similar insulation strip is placed in the slot between the top and bottom coil halves, and these strips should extend beyond the bend at each end of the coils, as at *B*. This prevents the top straps from cutting into the insulation of the bottom ones. A pad of one or more thicknesses of insulating material, such as treated duck, must be applied between the top and bottom coil ends as at *C*. These pads must be wide enough to protect the full width of the coil ends.

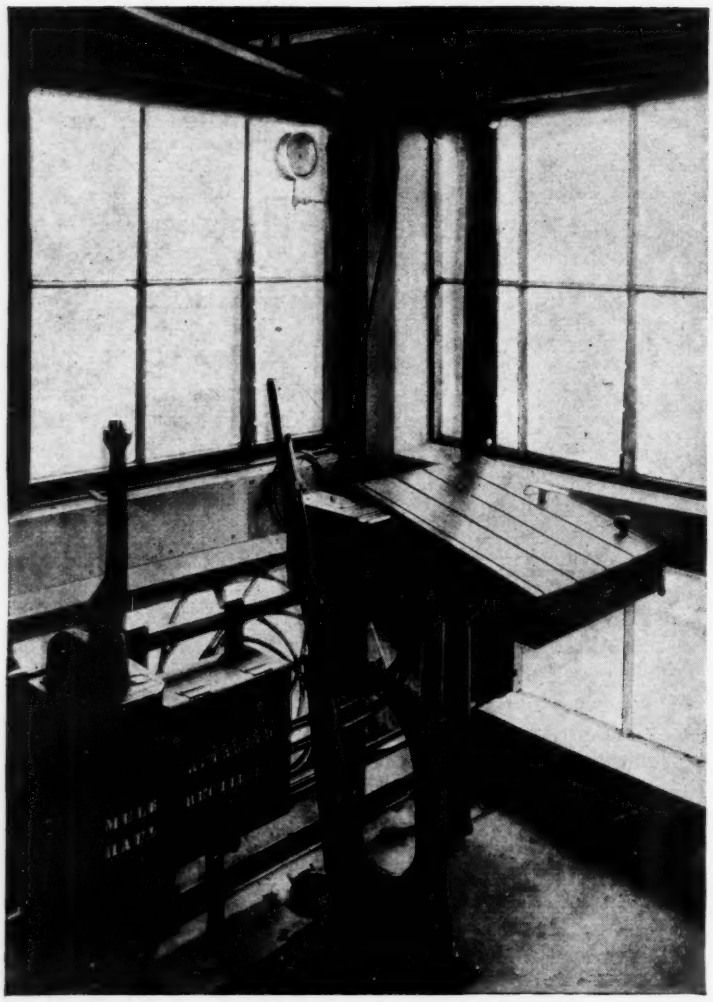


Extra insulation is indicated at *A*, *B* and *C*

A. C. Motors—Automatic Kick-Back—Photo Cell Signal

Are Features of

CAR DUMPING AT WAUKEGAN



Operator in control room uses electric eye to "see" returning cars

OWING to the unique methods used and the quick dispatch with which cars are handled, the rotary car dumper installation at Waukegan station of the Public Service Company of Northern Illinois is of unusual interest. The installation is the first of its kind to use all alternating-current motors and control. Formerly, the emptying of a car of coal by means of an overhead crane required a long time as compared with the three minutes used by this machine to bring the car up to the shed, dump it, and return it to the yard. The new car dumper is capable of handling twenty 120-ton cars per hour, a total of 2,400 tons of coal per hour.

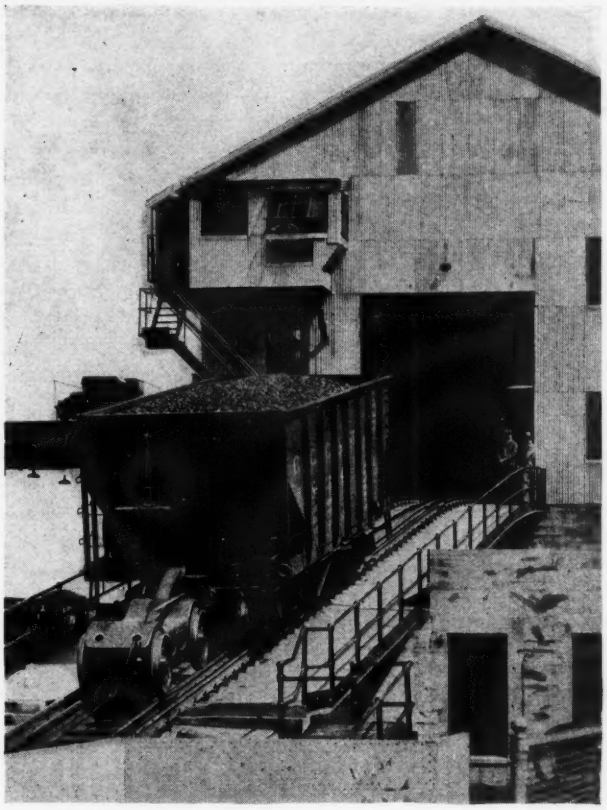
Loaded cars are pulled to the mule-haul by a motor-driven car-puller. The mule-haul is a small four-wheel car which runs on a narrow-gage track located between the rails of the standard-gage track. After the car is spotted over the pit, this mule comes up from the pit, is brought into contact with the rear end of the car, and, by means of a power-driven steel cable, pushes the car up the 15-deg. incline. After the car is in this position the mule is disengaged and returned to the pit.

A two-speed 25- to 100-hp. 440-volt 3-phase torque motor and a 500-hp. 2,300-volt 3-phase slip-ring motor are connected to a common shaft. This shaft is connected to the mule hoisting and lowering drum through herringbone gearing. By the use of contactors for accelerating and reversing the motors, of small contactors actuated by time closing relays, of geared type limit switches, of the torque motor to take the slack out of the hoisting cable and of a spring bumper to absorb the car mule engaging impact, an alternating-current installation has been designed that provides sufficient operating flexibility for all practical purposes.

Operation of the dumper consists of two movements. First rotation begins, a spring-operated transfer table moves the car toward the side of the dumper, and gravity-operated top clamps simultaneously descend. After rotating approximately 10 deg. the car reaches its side support and the top clamps continue to lower onto the top of the car. To fully discharge the contents of the car rotation continues through 180 deg. Then operations are reversed. The car is brought back to an upright position and the rails held in correct alignment by a solenoid brake.

One Man Operates System

The complete operating cycle of the dumper does not take more than one minute and forty-five seconds. The car is weighed both before and after dumping by a delicate scale showing an error not greater than 1/20 of 1 per cent. To keep down the dust the coal is sprayed with water while the car is being dumped. The empty car is then pushed out the back of the dumper by the succeeding loaded car. From the time the loaded car is spotted on the mule-haul track until it is discharged on the siding for empty cars the operations are carried



Mule pushing coal car up incline to rotary car dumper

on by one man. To secure uninterrupted performance the electrical control apparatus is located in a specially designed room equipped with an air filter to exclude coal dust or other foreign particles.

As the layout of the station site required that the tracks for empty cars be parallel to and at the same end of the dumper as the tracks for loaded cars, it was necessary to install a kick-back having an incline rising 27 ft. above the ground level. The car runs down the incline from the car dumper and up the kick-back. As it returns down the kick-back an automatic spring switch shunts it along a parallel track on the opposite side of the dumper from the operator's cab.

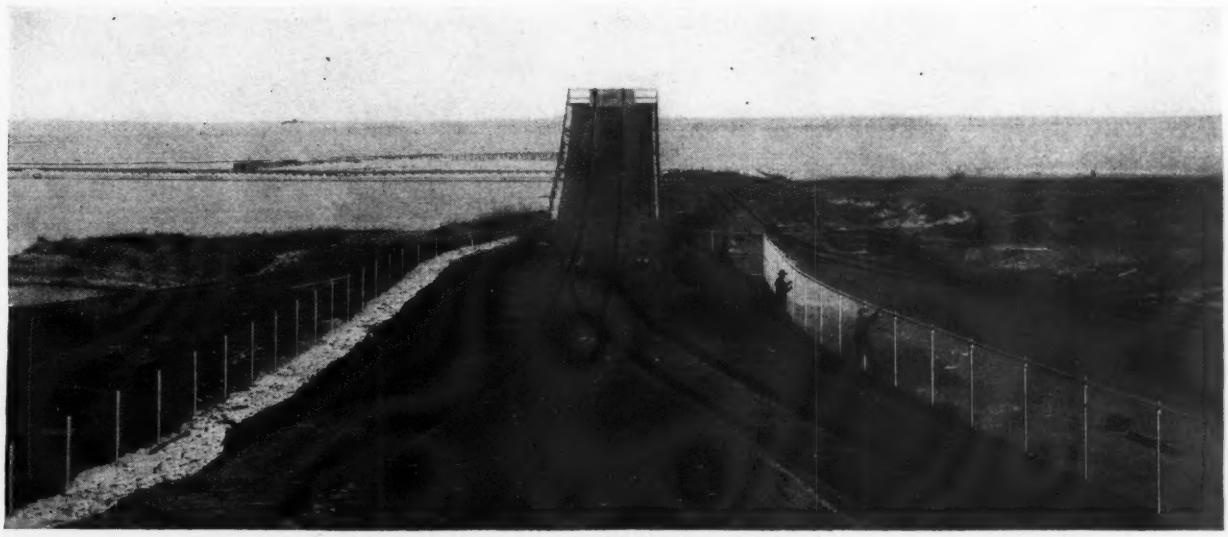
Since the returning car is invisible to the operator, some means must be had of telling him when the car is at a predetermined point on the return track and that it is necessary for him to operate the electro-pneumatic car retarding mechanism to slow down the car and thus prevent damage to other empty cars on the same track. A photo-electric relay unit, a light source and an alarm bell is the equipment used for this purpose. The photo-electric relay unit is mounted on one side of the empty-car return track and the light source on the opposite side of the track, the distance between the pieces of apparatus being about 25 ft. The light source is so located that the beam emanating from it strikes the photo-electric cell of the relay unit, causing the bell alarm circuit in the control cab to be held open.

Photo-Electric "Eye" Watches Cars

Although various other types of alarm systems could have been used the characteristics of the photo-electric relay made it particularly applicable for this installation. As the empty car travels down the return track, it cuts off this beam of light, causing the relay to close the alarm circuit and ring the bell in the operator's cab. The bell warns him that the car has reached the predetermined point and that the car retarding mechanism should be operated.

The car retarder consists of four sets of steel brake shoes operated by an air cylinder controlled by an electrically operated switch which is a part of the dumper operator's control. When a car enters the retarder the pressure of the inside brake shoes is in opposition to the pressure of the outside shoes. This equalizes the pressure on the car wheels, and at the same time provides a means of maintaining the center line of the car truck directly over the center line of the track.

Kick-back rising 27 ft. above ground level



One-Piece Construction Improves Condensers

By C. M. TAYLOR*

WITH the acceptance of the electric-arc process as a safe method of farbricating power-plant equipment which operates at high pressure, engineers have redesigned many units to secure the advantages offered by welding.

The old complaint against arc welding was that it was not a success; that to be specific, welds had low tensile strength and inferior ductility. The recent development for commercial use of various methods of shielding the arc is an important factor in the new acceptance of arc welding.

*Vice-President, Lincoln Electric Company, Cleveland, Ohio.

The condenser shown in Fig. 1 was constructed by this process, using coated welding electrodes: Bolts were used, of course, where interchangeability of parts was desired, but the condenser is, in effect, a single unit with few bolted flanges to invite leaks.

The unit, built by The Ross Heater & Manufacturing Company, is a 29,000-sq.ft. surface condenser installed and operating at the Northern States Power Company at Minneapolis. It serves a 35,000-kw. steam turbine, and condensing 300,000 lb. of steam per hour, it maintains a vacuum of 29 in. The shell was made in two pieces in the shop and later joined by field welding into one continuous shell. Welded construction eliminates several large bolted flanges with their gaskets which invite leakage. The weight of the shell is reduced about 25 per cent when compared with cast-iron construction.

Shell and Exhaust Connection in One Piece

Fig. 2 shows an 11,500-sq.ft. welded condenser, handling 120,000 lb. of steam per hour at 29-in. vacuum. The shell and exhaust connection piece are all fabricated as one piece, giving construction much superior to cast iron. To take up the difference in expansion between the brass tubes and steel shell an expansion joint is provided as shown at the left in the picture.

Fig. 1—Surface condenser of 29,000 sq.ft. welded by the shielded arc process.

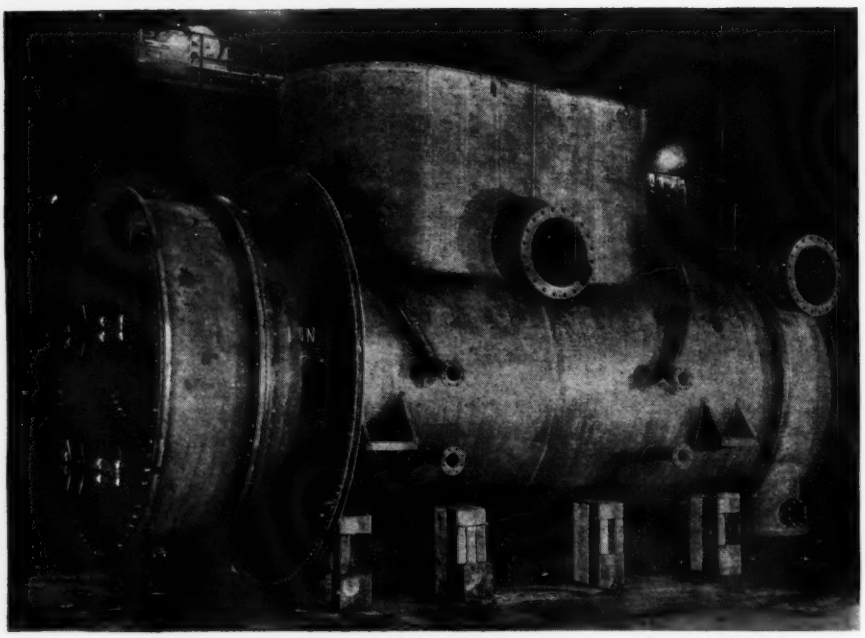


Fig. 2—View of the 11,500 sq.ft. welded condenser. Note expansion joint at the left.

Ventilation of Diesel Engine Crankcases

By EDGAR J. KATES
Consulting Engineer
New York City

ALTHOUGH the diesel engine compares favorably with other kinds of power plant equipment as regards its hazards to life and property, several serious accidents have occurred due to the vapors in the crankcase becoming ignited and blowing out the crankcase doors. Such accidents are entirely unnecessary, because they can be prevented by properly designed crankcase ventilating system.

Most diesel engines today are lubricated by force-feed systems which supply a large surplus of oil under pressure to the bearings, the excess being forced out from the ends of the bearings in thin sheets. Naturally, the engine crankcases are completely inclosed to prevent oil being thrown out into the engine room. As a result the crankcases are generally full of warm or hot oil spray and vapor. The vapor of hot lubricating oil, when mixed with air, is known to be explosive, and the danger of forming an explosive mixture is enhanced by the gradual lowering of the oil's flashpoint which usually occurs in service.

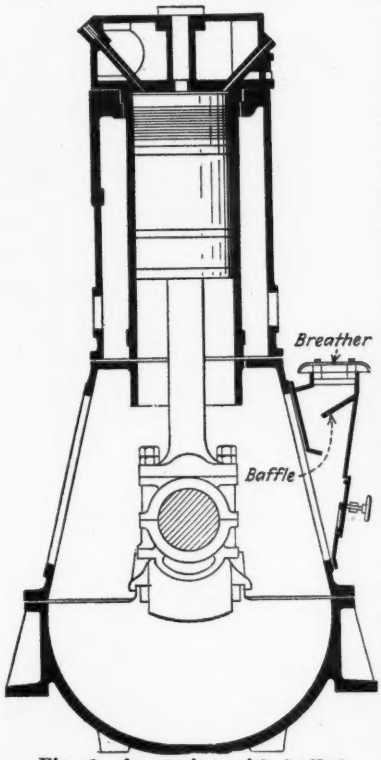


Fig. 1—An engine with baffled breather openings

To avoid the possibility of ignition the crankcase contents should be continuously cooled and removed. Even though the pressure produced by the combustion of the lubricating oil vapor is quite low, the surfaces exposed to it are large, and one or more crankcase covers are generally blown out with considerable force, releasing the flame into the engine room. It will be recalled that a crankcase explosion occurred on the M. S. Kungsholm in 1928, causing the death or injury of five men. While in this case the investigation indicated that it was the vapor of gasoline and not that of lubricating oil that had exploded in the crankcase, the gasoline having remained from a previous cleanup, the explosion would not have taken place if an adequate ventilating system had swept the combustible vapors out of the engine. In July, 1929, a crankcase explosion took place on the M. S. Triumph, killing one of the assistant engineers. A similar accident occurred in December, 1930, on the M. S. Max Albrecht.

Some engines merely have one or two shielded openings in the crankcase, as in Fig. 1. These so-called breathers serve to relieve the slight difference in pressure between the interior of the crankcase and the atmosphere of the room set up by the motion of the pistons and the blowby of the combustion gases. These breathers, however, are totally ineffective as regards changing the gases in the crankcase, as the movement through them is very slight.

An improvement on the simple breather is the system using a vent pipe leading from the crankcase to the air intake manifold, Fig. 2, or vents to the individual cylinder air intakes. The theory is that the air suction will draw off the crankcase vapors and consume them in the engine cylinders. While these vent pipes are a step in the right direction, they do not, of themselves, solve the problem of ventilation. It is obvious that their effect is simply to produce a vacuum of a pound or so at their junction with the crankcase, but whether this results in any movement of vapor out of the crankcase, depends upon what arrangements are made to admit fresh air to the crankcase in sufficient quantity and at the right places. If the crankcase is tightly sealed the vent pipes leading to the air intake simply draw off enough gases to put the entire crankcase under a slight vacuum, after which there is no vapor movement at all and hence no ventilation.

On many engines, however, there is an opening in the crankcase which admits fresh air, this being a small annular space around the crankshaft where it emerges from the bedplate. This space is generally designed quite small and is also obstructed with an oil catcher; it therefore admits only a little fresh air, insufficient for ventilating the whole crankcase. Consequently, the incoming air tends to ventilate only the adjacent end of the crankcase, leaving a dead pocket at the far end, unless, as illustrated in Fig. 2, the vent is taken from the opposite end of the crankcase.

In such cases circumstances may combine to generate an explosive mixture of oil and air, and to produce a spark to ignite the mixture. The ignition may be caused in many ways, such as by fire blowing by the rings, by a bearing running hot, or by friction due to a seizure or fracture. The latter is what happened in the M. S. Triumph. The crankcase of one of her 8-cylinder engines exploded, fatally burning an assistant engineer. According to the testimony at a subsequent court hearing, the immediate cause of the explosion was the breaking of an air-compressor piston; in the breaking up, a spark was produced which ignited the hot lubricating oil vapors in the crankcase. The engine was equipped with eight

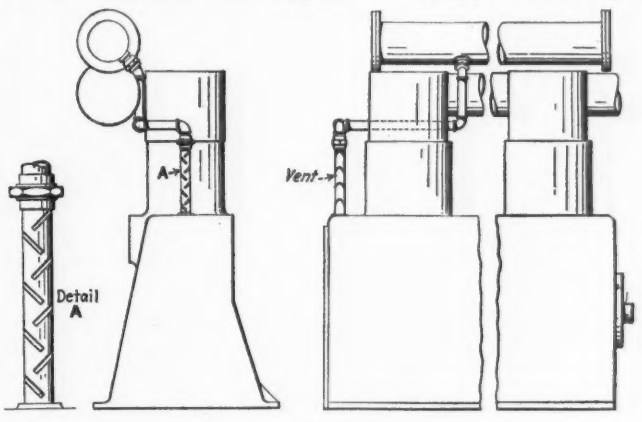


Fig. 2—Arrangement pulling the oil vapor into the intake manifold

vent pipes leading from the crankcase to the individual cylinder air intakes, thus affording ample means for withdrawing the crankcase vapor if sufficient fresh air could have entered to replace it. But the only way in which fresh air could enter was a small annular space from ¼ or ½ in. wide surrounding the crankshaft where it passed through the frame and bedplate at the flywheel end of the engine.

Such fresh air as entered the crankcase at this point naturally found its way through the nearer vent pipes, ventilating this end of the 30-ft. crankcase and leaving the other end full of the hot oil vapors produced during a long run in the tropics. It was at this end of the crankcase that the igniting spark occurred when the air-compressor piston broke. It is true that the accident was the outcome of an unfortunate and unusual combination of circumstances, but this did not mitigate its seriousness.

In view of ocurrences like these, diesel engine designers ought to give more attention to assuring real crankcase ventilation. This can be accomplished quite simply on four-stroke-cycle diesel engines, because the intake suction is available to produce a positive air flow. Automobile designers have provided crankcase ventilation for years, though they had to rely on the motion of the car itself to produce the air flow.

In an ordinary diesel engine it is only necessary to supplement the customary vent pipes from the crankcase to the cylinder suctions with a few air inlets to the crankcase, these inlets to be of sufficient size and to be so distributed as to admit plenty of fresh air to all parts of the crankcase, thus assuring complete ventilation. One way of doing it is shown in Fig. 3.

The ventilation must be complete enough to keep the crankcase vapors non-inflammable, either by making the mixture too lean to ignite or by cooling it below the danger point, or both. At the same time due precautions must be taken to avoid excessive loss of lubricating oil by shielding the air inlets to hold back the splash and by providing suitable baffles and settling spaces in the crankcase vents to catch and return the suspended lubricating oil.

In the case of engines having three or more cylinders the decrease in crankcase volume caused by the descending pistons is almost entirely equalized by the increase caused by the ascending pistons. They would be perfectly equalized if it were not for the angularity effect of the connecting rods. Accordingly, the crankcase pressure should never rise above atmospheric, as the momentary pressure increases should not exceed the partial vacuum produced by the vent pipes leading to the cylinder suctions.

In the case of single-cylinder engines and of twin-cylinders with cranks in line, the crankcase pulsations are much stronger. Satisfactory crankcase ventilation can still be effected by the positive air flow produced by the cylinder suctions, but the air inlets on the crankcase must

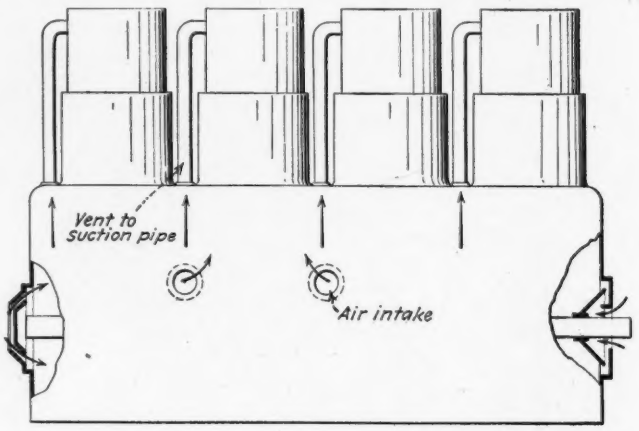


Fig. 3—Suggested arrangement of breather and vent

be designed with passages of sufficient length so that the momentary pressure increase due to the descending pistons will not expel the crankcase vapors through the air inlets and out into the surrounding atmosphere. If the inlet or breather passages are made long enough, the pistons, when rising on the next stroke, will cause a corresponding pressure drop in the crankcase. This drop together with the vacuum produced by the cylinder suctions, will completely draw back into the crankcase all vapors that had previously entered the breathers.

▼ ▼ ▼

Capacity of Long Control Wires Prevented Contactor Opening

By A. C. McHUGH
Norwalk, Calif.

IN THE operation of remotely controlled motors, the electrostatic capacity of the control circuit may cause faulty action of the motor's starter. A case of this kind recently came to the attention of the writer. A 50-hp., 440-volt, 50-cycle motor, driving a centrifugal booster pump supplying water to a storage tank approximately one mile away, was to be controlled by a float switch on the storage tank. Two No. 14 wires with a lead covering, installed in a ¾-in. conduit ran from the tank switch to the motor starter. It was found that closing the tank switch would start the motor, but opening this switch did not demagnetize the starting contactor's holding coil. A voltmeter test at the starter showed 440 volts at the coil terminals with the float switch closed and 285 volts across the coil with the switch open. The two control wires, being close together under the lead covering, formed a fairly good condenser and allowed sufficient current to flow to hold the contactor closed when the float switch was open.

A bank of lamps was connected across the line at the starter, and by changing the size of lamps a proper shunt resistance to overcome the effects of the control line's electrostatic capacity was determined. Then a resistor coil of approximately the same resistance as the lamps was wound and installed across the line near the starter. This solved the problem, and now the control circuit operates satisfactorily.

The pump is an important part of a domestic water system. In order that its operation may be observed, a flow meter of the electric recording type was installed in the pipe line, and the integrator and recorder placed in the boiler room so that the firemen are able to check the amount of water pumped, as well as the rate of pumping, in gallons per minute.

PRACTICAL AIDS

TO OPERATION

Methods of Deaërating Boiler Feed Water

A COMPARISON has recently been made between the two commonly accepted methods of deaërating boiler feed water. The older method of deaërating is by means of the condenser only. In some point of the plant cycle a surge tank is introduced to take up the differences that will exist, under the various conditions of plant load, between the quantity of feed water required in the boiler and the quantity of condensate being removed from the condenser. This surge tank is sometimes placed immediately after the condensate pump and merely floats on the line. Means are often taken to prevent aëration of water, such as by introducing vapor in the upper portion of the tank, as the water is commonly below 212 deg. F. However, in some plants surge tanks are connected just before the boiler feed pump suction, in which the condensate temperature runs slightly above 212 deg. F.; the surge tanks can then be vented to atmosphere or a vent condenser.

A more recent method of deaërating the boiler feed water is to add a deaërating open heater besides providing for deaërating in the condenser. This heater is fed with bled steam from the main turbine, and the temperature of the condensate is raised sufficiently to cause it to flash in the heater, thus relieving itself of dissolved oxygen. Occasionally this heater receives exhaust steam from steam-operated station auxiliaries.

When no deaërator is used an additional closed heater is required to make the cycles comparable, inasmuch as the deaërating heater is almost always fed from a turbine bleed point.

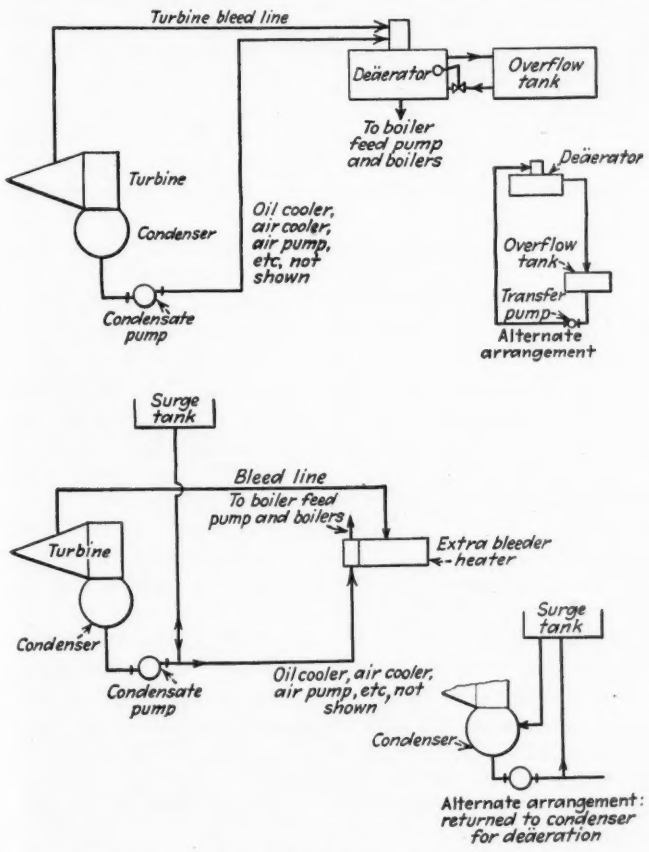
Comparing two equivalent systems, such as shown in the illustration, one using a deaërator and the other deaërating only in the condenser, the combined deaërating heater and its overflow tank would have a capacity equal to the surge tanks required in the system without the deaërator. In addition, precautions would have to be taken to preclude the aëration of water in the surge tank.

For a typical installation of about 200,000 lb. per hour capacity the costs would be approximately as follows:

	With Deaërator	No Deaërator Closed Heater
Price, f.o.b.	$14,600	$4,000
Freight and handling	1,400	700
Erection	2,000	600
Foundation	1,000	600
Total	$19,000	$5,900
	Overflow Tank	**Surge Tanks**
Price, f.o.b.	$3,000	$11,000
Freight and handling	300	1,000
Erection	600	2,000
Foundation	600	1,500
Total	$4,500	$15,500
Piping		
Condensate	.....	.....
Bleed	$1,500	$1,200
Overflow	1,500	1,500
Surge tank	.....	2,000
Heater drain and vent (no pump)	.....	500
Total	$3,000	$5,200
Total specific	$26,500	$26,600
Engineering, etc.	5,300	5,300
Grand total	$31,800	$31,900

From the foregoing, it is seen that either no saving or little saving would be effected by omitting a deaërating heater.

New York City. E. H. KRIEG.



Diagrammatic arrangement of two deaërating systems

Poor Equalizer Connection Causes Load Swings

A 100-KW. and a 250-kw. direct-current compound generator were operating in parallel, being driven by reciprocating steam engines. Both generators were made by the same manufacturer with characteristics suitable for parallel operation. The plant had been in operation a number of years when trouble developed from the load swinging back and forth from one machine to the other. It caused no serious difficulty for some time and it seemed impossible to locate the cause.

One night the trouble was so bad that first one machine would hog the load and then the other. The overload breakers tripped out on No. 1 machine and threw the entire load onto No. 2. The circuit breaker on No. 2 immediately opened accompanied by a flash at the machine's brush holders. It was found that the load swing had reversed the field-pole polarity due to the inductive kick from the suddenly collapsing field circuit, and that the brush-holders were badly burned.

An examination revealed that the trouble was caused

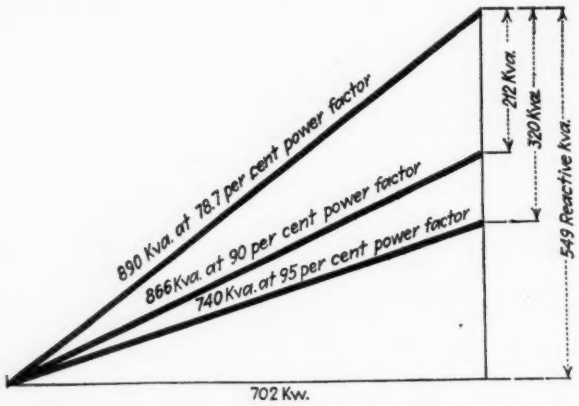
by the contacting faces of two connecting lugs of the equalizing line being badly corroded, and no amount of tightening would make a good connection. It was impossible to detect the cause of the trouble by an outside examination. From this occurrence it would appear to be a good policy to annually open all equalizer connections and clean them thoroughly.

Milford, N. J. H. M. SPRING.

Synchronous Condenser Reduces Power Costs

IN 1927 a power-factor clause was introduced into our rate schedule. The rate was so arranged that at 80 per cent power factor the old and the new rate were identical. As the power factor was improved the rate schedule made possible substantial savings. We did not know what our load's power factor was. At our request, the power company installed, temporarily, a reactive-component meter to operate in conjunction with a kilowatt-demand meter, so that both meters registered the same 15-min. demand intervals. The meters were read daily for about three months. By combining the readings of the two meters the power factor at the point of maximum demand was computed. The maximum demand was used in figuring the power bills.

It was found that the plant's power factor varied between 78 and 80 per cent. From the power bills for the three years previous, computations were made to show what the bills would have been if the new rate had been used, assuming 90 per cent and 95 per cent power factor. This calculation showed a possible yearly saving of $2,400 for 90 per cent power factor and $3,200 for 95 per cent power factor. We then arrived at the necessary


890 Kva. at 78.7 per cent power factor
866 Kva. at 90 per cent power factor
740 Kva. at 95 per cent power factor
212 Kva.
320 Kva.
549 Reactive Kva.
702 Kw.

Graphical representation of the power load

corrective capacity to bring the plant power factor up to 90 and to 95 per cent power factor by the method shown in the figure. The reactive kilovolt-amperes needed to raise the plant power factor to 90 per cent was found to be 212, and to 95 per cent, 320 kilovolt-amperes.

Capacitors for 30-cycle operation and of the sizes required were found to be too costly. This left the choice between synchronous motors or a synchronous condenser. The plant was examined for possibilities of substituting synchronous-type for squirrel-cage motors. It was found that the bulk of the plant load was concentrated in 100-hp. slip-ring motors connected to slow-starting, high-inertia loads. This was not a suitable application for a standard synchronous motor. In addition, these motors were fully loaded and operating at about 90 per cent power factor. The balance of the load was scattered about the plant in small motors. Investigation also showed that the corrective capacity in one unit cost only two-thirds as much as the same capacity in three units where substitutions could be made for existing motors. It was therefore decided to purchase a synchronous motor with a guaranteed capacity of 212 corrective kilovolt-amperes and operate it without load as a condenser.

This motor was installed in a convenient location with push-button control. It requires no attention other than routine inspection. In order to keep the operating losses to a minimum, it is only operated during peak-load periods, which in our plant are from 8 a.m. until noon, three days a week.

After installing this machine at a total cost of $3,000 the power factor at peak demand was between 90 and 95 per cent. After deducting the condenser operating losses from the savings, our power bills were reduced over $200 per month. D. BRADFORD APTED.

Grand Rapids, Mich.

Regulator Valve Diaphragms

RUBBER-COMPOSITION diampragms used in connection with diaphragm operated, spring loaded, or weight loaded regulating valves usually are very short lived when used on oil service. The side of the diaphragm exposed to the oil generally deteriorates very rapidly and necessitates frequent renewals.

This trouble has been experienced by the writer with rubber composition diaphragms on pressure regulators governing the steam flow to the auxiliary turbine driven oil pumps on several turbo-generators. The regulator in this case is, of course, actuated by the pressure in the turbine oiling system during start up and shut down of the main unit. In these instances the oil side of the diaphragm failed rapidly due to the oil attacking the rubber coating.

After several replacements of these regulator diaphragms had been made during the course of a few months, an idea was evolved to protect the oil side of the diaphragm while retaining the sensitiveness of the regulator.

A hardwood block 12 in. square and 2 in. thick was affixed to the face plate of a lathe. On this face and properly centered, was drawn a circle about 8 in. in diameter, the same size as the regulator diaphragm. Six concentric circles were then drawn starting at 2 in. in diameter. A "V" pointed tool was placed in the stock and shallow "V" shaped grooves were turned in the face of the block at the five concentric circles, each about $\frac{1}{16}$ in. deep and about $\frac{3}{16}$ in. wide.

A piece of brass shim plate about 10 in. square was then fastened to the face of the block and "V" indentations were spun into the surface of the shim, until the six "V" depressions were formed. Thus the surface of the shim plate was formed into a bellows surface. This plate was then cut to the same size as the diaphragm and reinstalled in the regulator on the oil side of the diaphragm, thus protecting the rubber from the oil.

Chicago, Ill. H. J. PRIBENSEN.

CURRENT COMMENT

Burning Cheaper Oil in Diesel Engines

IN AN EDITORIAL in the Dec. 8, 1931, number reference was made to supercharging of diesel engines. In order to avoid any misunderstanding with regard to the Büchi exhaust turbocharging system we would like to make some comments.

The statements made in the editorial are right as far as it concerns systems in which the supercharging units are driven directly from the engine shaft. In Büchi exhaust turbocharged engines, however, conditions are entirely different, as the exhaust gases are passed into an exhaust gas turbine which drives a turbo-compressor. The energy for pre-compressing the charging air is thus obtained out of the heat of the exhaust gases.

Such engines can, therefore, develop continuously a power 50 per cent in excess of that developed by an ordinary diesel engine of the same size. This particular feature of the Büchi system needs no further proofs; it is sufficient to mention its adoption. Over 300,000 hp. of Büchi exhaust turbocharged diesel engines are now in service of which nearly 250,000 hp. are in marine diesel installations and about 65,000 hp. in stationary plants. To mention only one, the "Reina del Pacifico" engines of 22,000 hp. are pressure-charged on the Büchi system.

It may be of interest to recount briefly the fundamental features of the Büchi exhaust turbocharging system. The cylinders are filled with air supplied by a rotary blower at a pressure substantially above that of the atmosphere. The exhaust gases are collected in one or more mains and led to an exhaust gas turbine. The latter is arranged on the same shaft as the blower. As previously mentioned, the energy necessary for pre-compressing the charging air is thus derived from the exhaust gases.

The Büchi system of turbocharging four-stroke cycle diesel engines provides an effective scavenging of the working cylinders when the piston is at its upper dead center. Scavenging is supported by inducing pressure fluctuations in the exhaust pipe. The volume and the cross-section area of the exhaust pipe and the inlet area of the turbine are so dimensioned that the pressure in the exhaust pipe rises at the beginning of the exhaust stroke and drops towards the end of the exhaust stroke substantially below the mean gas pressure. The mean gas pressure is about equal to the mean air pressure. This pressure difference between the charging air and the exhaust gases forces the scavenging air through the cylinder volume which consists of the compression space. During the scavenging period, inlet and exhaust valves overlap, that is, the inlet valve opens before the exhaust valve closes. The scavenging air volume amounts to around three to four times the momentary cylinder volume, that is, the compression space. The cool air flows through at a good velocity and has an important cooling effect on the cylinder head, the piston head and the valves. Hence the new charge flowing in will not be appreciably heated and an increase in weight of the new air charge results. For example, at a charging air pressure of 4 lb. per square inch gage, about 60 per cent more air is introduced than in an ordinary diesel engine. The exhaust gases in the compression space at the end of the exhaust stroke are entirely swept out by the scavenging air, while in the ordinary diesel engine they mix with the new air charge. The increased air quantity allows for a larger amount of fuel to be burnt in the same cylinder volume. At the same time the excess air ratio in the working cylinders of a Büchi turbocharged engine developing an output increased by 50 per cent, is still higher by about 20 per cent than in an ordinary engine. This fact and the increased output of the turbine and blower on overload allows for a temporary overload capacity of another 50 per cent.

The maximum temperatures and pressures in a turbocharged diesel engine are the same as in an ordinary engine. The stresses are, therefore, equal in both types of engines. The temperatures behind the exhaust valves are lower than in ordinary diesel engines as a further result of scavenging; in consequence of this the valves are much cooler. They need less attention and regrinding, and the reliability is increased. Consideration of mean process-temperatures, that is, the mean temperatures over the whole working cycle, shows that the mean process-temperature of the turbocharged engine is practically the same as that of an ordinary diesel engine because of the scavenging. This explains why the heat transfer and the cooling water heat are considerably lower. Prof. Dr. A. Stodola carried out tests with a diesel engine turbocharged on the Büchi system and he stated that the cooling water heat was extremely low, amounting only to 1,620 B.t.u. per brake horsepower hour against 2,100 B.t.u. in ordinary diesels. The wall temperatures are consequently even lower. The serious problems of heat distribution mentioned in the editorial do not relate, therefore, to exhaust turbocharged diesel engines with scavenging.

The reduction of the fuel consumption is another outstanding feature of the Büchi turbocharging system. Supposing an ordinary diesel engine to have a fuel consumption of, say, 0.40 lb. per brake horsepower hour, then the fuel consumption will be around 0.36 lb. when the engine is turbocharged on the Büchi system. If a supercharging equipment in which the blowers are driven mechanically from the engine shaft, is used, the fuel consumption will be increased up to 0.445 or 0.45 lb. It is evident from this that systems not utilizing the energy of the exhaust gases, those with directly or electrically driven blowers, lead to a high price in horsepower. It is worth while considering exhaust turbocharging as a first step towards reducing power cost by around 10 per cent. The friction losses account for this improvement because they remain practically constant at any load in consequence of the same maximum cylinder pressures.

With regard to the price of a turbocharged engine there is no doubt of its being the cheapest solution. The turbocharging unit replaces one-third of the working cylinders.

ALFRED BUCHI,
Winterthur, Switzerland The Büchi Syndicate.

READERS' PROBLEMS

PITTING OF WATER BOILER—*A plant manufacturing vegetable products has a vacuum evaporator heated by circulating hot water through copper tubes. The water is heated by a firebox type return tube oil-burning boiler, working at about 110 per cent of rating and is circulated at a high rate by a centrifugal pump. The hot water is kept at 175 deg. F., the return is about 140 deg. F.*

The boiler has given trouble due to severe tube pitting. The circulating water is slightly alkaline and contains nothing that should give trouble in a hot-water system. Apart from a vent in the overhead expansion tank, there is no place where the water can absorb air. The system requires almost no make-up water. There has never been any evidence of vegetable acids leaking into the heating system.

It has been suggested that the trouble is due to galvanic action between the copper and the steel, and that the boiler tubes are attacked first on account of their higher temperature and exposure to the flow. The remedies proposed are the use of zinc strips in the boiler, of the installation of electrically insulated joints in the pipes near the evaporator.

Do you think that galvanic action could cause this pitting, and, if so, what steps should be taken to correct the trouble? M.P.T.

Galvanic action could cause the pitting, and the suspension of zinc bars in the water space should eliminate the trouble, if due to galvanic action. It would be well to test the boiler water for acidity.

The pitting has all the characteristics of oxygen corrosion but the presence of oxygen seems impossible from the question. However, if the pump is operating under a vacuum at the suction, air may leak in along the pump shaft. The continuation of even a minute leak would in time add a perceptible amount of oxygen to the water.

PUMP PISTON STRIKES HEAD—*We are operating two direct-acting duplex steam pumps and cannot prevent the pistons striking the heads of the steam cylinders.* R.D.

A steam pump of any size has cushion valves between the pair ports at each end of the cylinder. One of these ports is used for exhaust, while the outer one admits live steam to the cylinder. As a consequence the piston overrides the exhaust port and traps the rest of the cylinder charge of steam, and this clearance steam acts as a cushion to stop the piston before it strikes the head. The cushion valve between the exhaust and steam port permits part of this trapped steam to pass up the steam port and wire-draw into the exhaust port, thereby preventing short-stroking of the pump due to early compression.

To adjust the cushion valve run the pump without a water load and with the cushion valve wide open until the piston strikes the head. If the piston strikes too hard adjust the play in the slide valve rod, and do the same if the piston does not strike. Next place the pump under load and close the cushion valve until the piston stops striking the cylinder head.

If no cushion valves are on the pump, set the slide valve rod adjusting nuts until there is just enough play to permit the pump to make full stroke without striking.

▼ ▼ ▼

Will the Cheaper Coal Pay?

Summary of Readers' Opinions on the Previous Question

OUR THREE 6,000-sq.ft. boilers are equipped with underfeed stokers. At present we are burning run-of-mine having a fusion temperature of over 2,200 deg. F., but are offered slack having a fusing temperature of below 1,900 deg. F. at a reduction of $2 a ton. The heat value is but slightly less than that of the run-of-mine. Will the stokers handle the coal? C.J.K.

It Won't Work!

BITUMINOUS SLACK cannot be burned successfully with underfeed stokers; it clogs up and packs too tightly, particularly so if it is at all damp. If exposed to the weather it will absorb considerable moisture in wet weather. It is difficult to get sufficient air to the fire, the air spaces will either clog up or blow holes will be caused; by the time it reaches the side grates there is nothing left but ashes, making considerable more work to handle it with unsatisfactory results. R. W. CATER.

Westville, N. J.

It Will!

WE HAVE been using slack coal of low fusing quality in our underfeed stokers for 12 years with good success with heavy peak loads. The secret of success is to admit enough steam with the air under the retorts.

In our case we use the exhaust from the stoker valves. W. J. LAPWORTH.

Pittsburg, Kan.

Try It Two Months

THE ANSWER to C.J.K.'s question depends considerably on the rating at which his boilers are normally run. If they operate at from 100 to 150 per cent of rating with from 2 to 3 in. of air pressure in the wind-box I think advantage of the low cost fuel should be taken. However, if higher ratings, say 200 to 300 per cent with from 3 to 5 in. of air pressure, are to be experienced, a coal with a low fusion temperature should be avoided.

At low ratings the tail of the fire is at a relatively low temperature and clinker trouble can be eliminated if the fire is kept clean by frequent dumpings. With higher ratings and correspondingly higher air pressures, a coal with a tendency to blow soon covers the area over the dump plates with a layer of white hot coke. The heat is sufficient to fuse the ash with resulting trouble in dumping and from burning out dump plates.

The question that C.J.K. must decide is whether a reduction in fuel cost will over-balance an increase in labor and maintenance cost, a reduced rating due to the molten ash blanketing some of the tuyeres and a reduced efficiency due to a greater ash pit loss. My suggestion is that C.J.K. try the coal with the low fusion temperature for one or two months and compare the operating costs of the two coals for similar ratings and conditions. This is the best way to test a coal since it is only by means of experimentation that the characteristics of coals may be determined.

GORDON R. HAHN.

Astoria, N. Y.

Don't Drive Fire

IT IS POSSIBLE to change from a run of mine to a slack, lower fusion ash temperature coal, using underfeed stokers, but a change of firing methods will likely be necessary. To burn the same amount per sq.ft. of grate surface will require more windbox pressure, because of the increased resistance through the fuel bed. Damper changes may be found necessary to maintain proper combustion.

The low fusion characteristic will be evident at and beyond the overfeed grates, so for the best results the fire should not be carried as heavy at those places as can be carried with run-of-mine coal. Let it be only heavy enough to give good combustion gases beyond this point. Keep the green coal confined to the underfeed section. Bad clinkering will result unless it is.

A heavy fire, with its accompanying high temperature on the overfeed grates, aggravates the low fusion objection.

By keeping the fire lighter and cleaning before any bad clinkers accumulate, results comparing favorably with run-of-mine coal at a higher price can be obtained.

To facilitate the combustion during the underfeeding process I recommend dampening the coal, as evenly as possible.

Due to the low fusion temperature, the grate maintenance, especially of overfeeds and dumps, will increase considerably. GEO. B. LONGSTREET.

Keyport, N. J.

It Depends on the Weather

C.J.K. SHOULD CONSIDER the per cent of ash he might get before making the change, since slack coal is that which will pass through a bar-screen with ¾-in. openings. During rainy weather slack coal will absorb large quantities of moisture and make unloading somewhat difficult. Unless this coal is purchased from a reliable company, you may experience trouble with tramp iron.

Underfeed stokers will handle slack coal. The hoppers will have to be watched during periods of wet weather as the fine particles in the coal will become sticky and not allow the coal to slide down to the front rams. During periods of dry weather the wind boxes will have to be examined for siftings through the grates. The small size of this coal will cause large bodies of coke to form inside the furnace and the secondary ram and moving grate motion will have to be changed to break up the coke formation, before it reaches the dump grates.

The low fusion point of the ash will give trouble on the dump grates. If too much combustible is allowed to accumulate on the dump grates, this will cause clinker adhesion on the bridgewall. Each time the grates are dumped, part of the brickwork will be taken off, unless some provision is made to stop clinker adhesion. If the stokers do not have a rear water wall, the clinker adhesion may be kept down by admitting steam from the stoker engine into the rear wind box under the dump grates.

GEORGE G. AVANT.

Charlotte, N. C.

Look Out for Trouble

THE SUBSTITUTION of slack coal for run-of-mine simply because of lower price per ton and approximately the same calorific value when the fusion temperature of the ash is known to be 300 deg. lower is open to serious question. The following conditions with respect to the stoker equipment and the load conditions must be given first consideration in the selection of fuel for underfeed stokers.

Furnace flame temperatures of 2,900 deg. F. will not cause excessive clinkering of coal whose ash fusion point is 2,200 deg., but coal of 1,900 deg. would probably cause troublesome clinkering at the same rating. This sticky clinker on an underfeed stoker burning slack in particular would run and fuse over the green coal beneath, causing excessive loss in combustible in the ash pit and high grate maintenance costs due to burning of the grates, and would require excessively high forced draft to maintain rating.

The area of the grates and the ratio of grate length to width should be carefully considered too, as combustion rates as high as 38 lb. of coal per sq.ft. of grate surface with coal of 1,900 deg. ash fusion point would be unsatisfactory if not impossible with slack coal. Moreover fly ash from slack might cause serious trouble where run-of-mine coal did not.

The entire question resolves itself, as does every engineering question, into one of economics.

Judging from experience I would proceed with caution to change from run-of-mine to slack of lower ash-fusion for a difference in price of $2.00 a ton.

RAYMOND F. FORBES.

Indianapolis, Ind.

A Question for Our Readers

EXHAUST STEAM is delivered to all parts of our factory at 10 lb. gage pressure for heating and process. All steam is generated at 150 lb. pressure. A reducing valve from 150 lb. to 10 lb. is installed but rarely in operation, because the 10-lb. exhaust generally exceeds the requirements. Some of the 150-lb. steam is piped to one department and there reduced to 50 lb. for special process work requiring that pressure. It has been proposed that we save a certain amount of the 150-lb. steam by taking the 10-lb. steam available in this department and there boosting its pressure to 50 lb. The total amount of 50-lb. steam required averages about 2,500 lb. per hour during the working day, with a peak load slightly higher.

How much advantage would there be in saving high-pressure steam in this way? In what ways could the boosting be accomplished? Which is the most practicable from the point of view of cost, ease of operation and reliability? J.F.M.

Suitable answers from readers if received promptly, will be paid for when published. Typewritten replies should preferably be double spaced.

Combustion Rate Is Limitation

THERE ARE many factors which influence the firing of low-fusion-ash coals on underfeed stokers. These include the shape of the furnace, its construction, whether solid refractory air cooled or water cooled walls, and the heat release per cubic foot per hour.

However, it is assumed that the question asked concerns the stoker primarily, and difficulties that may arise in its operation with a low-fusion-ash coal. Such being the case, the answer depends largely upon the rate of firing.

With coals having ash-fusion temperatures from 2,200 deg. F. to 2,600 deg. the maximum coal feed rates are from 60 to 70 lb. per square foot of stoker per hour for short periods; while rates of from 40 to 50 lb. can be maintained continuously.

However, underfeed stoker coals of low-fusion ash temperatures, i.e.: 2,100 deg. and under, are generally not satisfactory due to the ash coming up through the fuel bed into contact with the highly incandescent fuel.

It is therefore to be questioned whether this coal will give satisfactory results if fired at rates in excess of 40 lb. per sq.ft. of stoker per hour for peak loads and 30 lb. for continuous operation.

R. S. JULSRUD.

New York, N. Y.

Steam Jets Help

A POSSIBLE reduction of two dollars a ton in the purchase price of coal is very attractive and, if the moisture and heat value of the low fusing ash coal compares favorably with the higher grade coal, a substantial saving should result.

The type of stoker used is not mentioned so we will assume they are of the multiple-retort inclined-grate type. We have burned slack with an ash fusing point under 2,100 deg. F. successfully by giving attention to the following.

Exhaust steam was used to moisten the coal in the stooker hopper by placing a jet at the entrance of each retort. This helps to hold the slack together until it reaches the high-temperature zone, where it is baked together preventing the forced draft from blowing holes in the fire.

A perforated steam pipe along the grate on each side wall serves to cool the wall and prevents clinker sticking to the firebrick.

Sufficient air is used on the extension grates to burn out the remaining coal and cool the clinker. The clinker can then be broken up and dumped without further trouble. Avoid the use of the slice bar as stirring the fire makes matters worse.

Experiment will determine the correct depth of fire, stoker speed and air pressure but high ratings will not be practical with this kind of coal.

ELMER N. ANDERSON.

Austin, Minn.

Trends in the Design and Operation Of Large Underfeed Stokers

Prime Movers Report indicates that future furnaces may be designed to fit stoker, rather than the reverse. Major operating limits are clinkering and blowing the coal off grates. Maintenance cost varies between 3 and 20c. per ton

SEVERAL significant trends are pointed out in the recent report of the Prime Movers Committee (N.E.L.A.) on stoker equipment and furnaces. In particular, it is shown that maximum underfeed stoker widths have increased but little since 1920, and that the new trend may be the design of furnaces to permit wider stokers, and hence greater capacities. The effect of clinkering and lifting of fuel from grates, as limiting factors in capacity, are pointed out. The report lists stoker maintenance costs, including material and labor, between 3 and 20c. per ton.

Excerpts from this report follow:

The demand for lower investment cost per kilowatt of installed capacity has created a demand for larger steam-generating units. Stoker-fired boiler units with designed capacities in excess of 500,000 lb. of steam per hour are being installed. Manufacturers have expressed a willingness to build stokers of sufficient capacity to generate in excess of one million pounds of steam per hour in a single unit.

Design of Underfeed Stokers

In general, the width of the stoker has been determined by the width of the boiler, so that during the past two years the increased grate area has, in large part, been brought about by an increase in the length of the stoker. In many cases the most desirable means of obtaining additional grate area is by increasing the width, rather than by increasing the length.

There seems to be no practical limit to the width of stokers, now that expansion troubles arising from the use of preheated air have been largely overcome.

The widest stoker in use in this country at the present time is 31 ft. 7 in., yet in 1920 stokers were installed having a width of almost 30 ft.

Furnace design permitted an increase in stoker length, so larger capacities were obtained by extending the grate in this direction. The change in length was sponsored by a better understanding of the basic principles of combustion, and led to improved designs for the distribution and control of the fuel bed at the rear of the stoker. The longest stoker in existence is now being installed at the Hudson Avenue Station of the Brooklyn Edison Company. This has a grate length of 26 ft. 7 in., and a grate area of 694 square feet.

Size Limit Not Reached

The size limit of stokers has not yet been reached. The practice of adapting the stoker to the setting is being reversed, and furnaces are now adapted to meet the requirements of the fuel-burning equipment. Stokers with large grate areas demand careful attention to the design of the coal-feeding and distributing mechanism, and ample control for the proper distribution of the air to the grate.

> "There seems to be no practical limit to the width of stokers, now that expansion troubles arising from the use of preheated air have been largely overcome."

The reports submitted by operating companies disclose that the major factor limiting the maximum continuous capacity of underfeed stoker-fired units is the clinkering of the fuel bed and blowing the coal off the grate. The other factors, in the order of their importance, are the slagging of boiler and superheater tubes, smoke, limitations due to draft equipment, and the thermal performance of the unit.

The fuel-burning equipment is the fundamental limiting factor. The limit due to lifting the fuel from the grate is one that cannot readily be controlled, although one company reports that adding moisture to coal increases the operating range to some extent.

Ash will fuse on the grate while the fuel is undergoing combustion. One of the most difficult problems in underfeed stoker operation is to move the refuse along with the burning coal without forming troublesome clinker. The extent that clinker is limiting the capacity of stoker installations discloses the importance of careful design and skillful operation to reduce clinker troubles. Water walls have reduced the clinkering of the fuel bed along the wall section of the stoker. The stoker design, however, must seek to reduce clinker formation on the grate, particularly as affected by air distribution and the movement of the fuel bed.

The slagging of boiler tubes, in general, is not serious with underfeed stokers. The slag, however, is composed of large particles forming a dense deposit difficult to remove. Slag troubles are most experienced in those installations where low-fusion ash coal is formed.

Maintenance costs for underfeed stokers installed during the last five years were reported by several operating companies. Stoker maintenance cost, including material and labor, varies between 3.0 and 20.3c. per ton of coal burned. The stokers using preheated air show a weighted average in maintenance cost of 17.0c. per ton, while those using air at room temperature show 8.6c. per ton.

> "The practice of adapting the stoker to the setting is being reversed, and furnaces are now adapted to meet the requirements of the fuel-burning equipment."

For stoker drive the direct-current motors are well suited, from the standpoint of operation, but are not strongly favored because of the expense of the converting apparatus.

The low first cost of two- or four-speed alternating-current motors, with gear-shifting devices, favors this scheme, which has been adopted by several companies. This arrangement, however, does not provide ample operating

flexibility for widely changing loads. The wound-rotor type of alternating-current motor will improve this speed control, but the cost is higher, and its efficiency is low at the lighter load.

The steam turbine used by some companies is ideal for stoker drive. It offers a wide speed range, but the installation is complicated by steam piping. The steam rate of stoker turbines is relatively high, and the desirability of their use depends upon the station heat cycle or the demand for low-pressure steam.

The electric-hydraulic stoker drive uses a single-speed induction motor, but provides a variable-speed control equal in flexibility to that obtained when direct current is used. The cost of hydraulic drive has been reported by an operating company as being less than the cost of a complete system of Ward-Leonard drive, while the over-all efficiency is approximately the same.

Furnaces and Water Walls

The high rates at which heat is absorbed by water-cooled surfaces in furnace walls demands that the boiler-feed water be free from scale-forming impurities. This, however, does not mean that distilled water is necessary for boiler feeding. Water-wall installations are operating successfully where treated make-up constitutes over 50 per cent of the boiler feed, the concentration being controlled by blowdown.

"Water-wall installations are operating successfully where treated make-up constitutes over 50 per cent of the boiler feed, the concentration being controlled by blowdown."

The heat absorption rate in furnace walls adjacent to the fuel bed may reach 80,000 to 100,000 B.t.u. per hour per square foot of project area. Under extremely severe conditions, accompanying flame impingement, it may rise considerably above these values. Experience discloses that no serious troubles are likely to be encountered due to the high rate of heat absorption, unless tubes are subject to flame impingement, or the tube of metal is inadequately cooled due to presence of scale.

Air Preheaters and Preheated Air

The reduction in furnace-wall maintenance, due to water cooling, has encouraged the use of higher air temperatures. Temperatures up to 600 deg. F. are being used, while higher temperatures are being considered.

Preheated air sometimes affects the way coals will burn on the grate. Elevating the air temperatures may change the coking properties of the fuel, making fuel bed control exceedingly difficult. The fuels that disclose this characteristic as the temperatures are raised are in the minority, and this trouble is not generally experienced.

The troubles with air preheaters center about the fouling and corrosion of the heating surfaces. Corrosion is usually due to the low temperatures that prevail at those sections of the preheater where the gases come in contact with the surface cooled by the cold air entering the preheater. Limiting the minimum temperature at which air enters the preheater has proved to be advantageous, and this practice has developed to the extent of automatically controlling the temperature of the entering air by bypassing the heated air to the inlet side of the heater.

"The stokers using preheated air show a weighted average in maintenance cost of 17.0c. per ton, while those using air at room temperature show 8.6c. per ton."

Heaters were installed during 1928 using air at a maximum temperature of 560 deg. F. The experience with installations employing such high preheat disclosed maintenance troubles, and no installations have since been made for which the maximum air temperature exceeds approximately 450 deg. F.

The trend in recent years is to be more conservative in the application of preheat with stokers, limiting the average temperature to 350 deg. F.

Experiences of operating companies with air preheaters installed with stokered boilers reveal that fouling and corrosion troubles are generally encountered. Preheated air is recirculated, under manual or automatic control, to prevent lowering flue gas temperature below the dew point. One company reports that corrosion troubles were reduced by correcting the distribution of air and gas passing through the preheater.

"The trend in recent years is to be more conservative in the application of preheat with stokers, limiting the average temperature to 350 deg. F."

Some companies are washing preheaters when out of service for cleaning, in order to remove deposits, but others that have washed them abandoned this method of cleaning because it apparently increased corrosion. Regenerative heaters have been so seriously plugged that one company reports the preheater element was dismantled in order to clean the gas passages.

Soot blowers are also in general use to clean preheaters. Experience with these installations discloses that steam pressure must frequently be raised at the soot blower element above that normally anticipated, to effectively remove deposits. Soot blowers, unless properly installed, may contribute to fouling and corrosion rather than keep the preheater free of deposits. Stoker installations are particularly affected in this manner, because the deposits in preheaters are generally of a nature that cannot be removed by steam jets.

Automatic Combustion Control

The increased use of automatic combustion control equipment indicates that many operating companies accept it as being sufficiently reliable to use in place of manual control to regulate steam pressure and to maintain economical relations between the fuel burned and the air supplied to the furnace.

Automatic control systems appear to have been installed in an attempt to improve operation without increasing the number of operators.

No operating company has reported great dissatisfaction with the manner in which its control equipment accomplishes the purpose for which it was installed. One company reports greater sensitivity to be desired. Apparently each installation requires adaptation and adjustments peculiar to local conditions.

"Manufacturers have expressed a willingness to build stokers of sufficient capacity to generate in excess of one million pounds of steam per hour in a single unit."

There seems to be a demand for a reliable control device which will be actuated by the CO_2 in the gaseous products of combustion. At the present time, so it is reported, gas flow is being regulated in an attempt to obtain the desired CO_2 content.

Reports on maintenance cost of combustion-control equipment indicate that in the ordinary installation the cost is small. There are not sufficient data available to present it in concrete form. It is hoped that the users of this type of equipment will make an attempt to determine what these costs really are.

Automatic control is at times applied to only a few of the several boilers in a given plant. In such cases the capacity range of the boilers under automatic control becomes a most important factor. Some companies report that in such installations they find it desirable to control steam pressure manually, using the automatic equipment only for the purpose of centralizing control and proportioning the fuel and air supply.

The Use of Low-Rank Fuels in Canada

AN EXHAUSTIVE PAPER in the January number of the *Engineering Journal* (Engineering Institute of Canada) reviews methods used and proposed for the utilization of the low-rank fuels found in the Dominion. The paper was prepared by E. A. Allcut, professor of mechanical engineering, University of Toronto, and H. L. Wittek, consulting engineer, Toronto. The following information is taken from it.

Great Reserves of Low-Rank Fuels

The sub-bituminous coals and lignites of Canada are estimated at over a billion short tons and comprise 77 per cent of the fuel resources of the country. Peat bogs form a fuel reserve of nearly 35,000 million tons, of which 114 million tons is favorably situated in relation to industrial centers where better fuels are not cheaply available. In addition great quantities of bark and other wood refuse are available as byproducts of the lumber and other wood industries.

Low-rank fuels, from their very nature, are not commercially usable at great distances from their point of origin.

Moisture is a primary consideration in such fuels, since it ranges from 20 to 80 per cent by weight. The moisture may be so high as to utilize all of the theoretical heat of combustion for its evaporation. A considerably lower degree of moisture is, of course, necessary for practical use, so that most of these fuels require pre-drying.

In this respect peat, with an initial moisture content as high as 90 per cent, offers the most difficult problem. Moisture can be reduced to only 70 per cent mechanically, and further drying must be achieved by the use of waste heat to be commercially practicable. Such waste fuels as bark and lumber waste are also high in moisture.

It is possible to reduce the moisture content of lignite from 35 per cent to 15 per cent by using waste gases, but generally at the risk of promoting disintegration.

Commercial development of the Holzwarth internal-combustion engine and of the solid-fuel-burning diesel-type engine, such as the "Rupa," may open new fields for the use of some of these low-rank fuels in pulverized form.

Combustion on Grates or Stokers

For burning wood refuse on grates or stokers, flat or inclined grates, usually inclosed by some form of dutch oven, are commonly used. The fuel bed should not be disturbed any more than is absolutely necessary. Coal- or oil-fired burners are used in addition to those burning wood waste, in many cases, to take care of fluctuating loads.

The use of preheated air in wood-burning furnaces gives increased steaming capacity and greater efficiency.

Most of the Canadian lignites are found in the West. They are conveniently classified by their moisture content. Different classes have different burning characteristics and therefore should not be mixed in the hopper or used at the same time.

Class A lignites, ranging from 10 to 22 per cent moisture, are tough in structure and will stand considerable handling without appreciable breakage.

Class B lignites (22 to 26 per cent moisture) can be stored successfully, but deteriorate to a greater extent than Class A. They give more serious maintenance trouble. Class C lignites (26 to 30 per cent moisture) have storing characteristics similar to those of Class B but do not form bad clinkers.

Class D lignites (over 30 per cent moisture) crumble when exposed and are the most difficult to burn. Forced draft is generally necessary with the smaller sizes.

The following optimum conditions are laid down by R. L. Sutherland for burning lignites:

1. A minimum amount of free oxygen at the surface of the fuel bed, the best thickness of which varies with the age of the fuel and its size.
2. A uniform flow of air in proportion to the load.
3. Minimum disturbance of fuel bed.
4. Horizontal, or nearly horizontal, non-sifting grates.
5. Forced draft with or without preheat.

Hand-firing of lignites with natural draft is usually not economical, as large sizes of coal are required (between two and six inches) and considerable skill is necessary on the part of the fireman.

Natural draft is also uneconomical with traveling grates. Fair results may be obtained with traveling grates equipped with forced draft, sectionally controlled, non-sifting grates and ignition arches with a secondary combustion chamber above them.

Many Western lignites can be burned on underfeed stokers. Some, however, pulverize in the retorts and stop or break coal pushers. The maximum rate of burning is from 60 to 70 lb. per square foot per hour. As a general rule, only the higher grades of lignites can be handled satisfactorily on underfeed stokers. Some of the Alberta coals fall in this group.

The conditions necessary for burning wood waste in suspension are similar to those involved in the combustion of pulverized coal. The fuel must be in a uniform finely divided state, and a high boiler setting is required. Such conditions can usually only be fulfilled economically in installations of comparatively large capacity. The cost of preparation is an offset to the economical use of fuel in this form.

In some instances a part of the wood fed into the furnace is burned in suspension, while the remainder is consumed when it reaches the grate.

While lignite is burned in pulverized form, it offers certain difficulties not found with coal because of its high moisture content, with resulting increasing cost of drying, and its low heat content, which requires the pulverization of a much larger quantity of material.

The complex nature of fuels containing large percentages of volatile matter has directed considerable attention to the possibility of analyzing them into their component parts, with the subsequent use of each component to the best advantage. It is probable that as solid fuels become scarcer and more expensive this method of handling them will become a necessity, and therefore the time and money spent upon such processes will have been well expended in the long run. The present possible applications are greatly limited by the market for byproducts.

Reusing Babbitt

By A. H. LEVY

ACCORDING to government statistics, the consumption of babbitt has been steadily declining. While the reason for this is due, in the main, to the general business condition, many plants are reducing their babbitt purchases by using old babbitt for relining their bearings.

It is a known fact that a bearing lined with scrap babbitt cannot stand up under stress and shock as well as one lined with new babbitt. Aside from the fact that the old babbitt is suffering from "fatigue," it is further weakened by the dirt and oil which have found their way into the pores of the metal. The porousness in most bearings lined with scrap babbitt, and the blowholes, is for the most part, due to the dirt in it and the oil that has seeped into it.

While there is no way to revitalize babbitt that had been in service for long periods, the metal will make a better bearing if it is freed from the dirt and oil. In this connection, a lesson may be taken from the printing industry. In most of the printing plants where linotype and stereotype metals are used the metal is periodically cleansed.

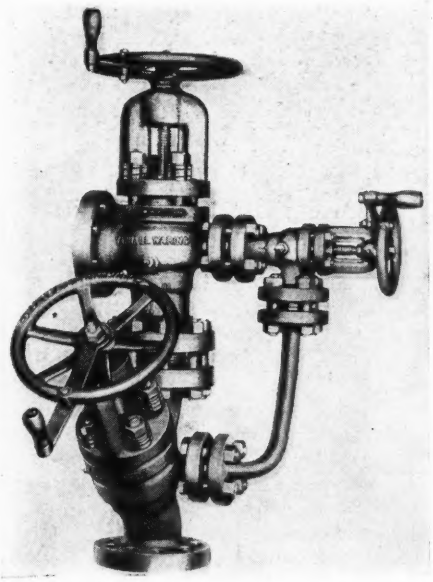
The process is simple. While the metal in the remelting-pot is molten, a cleaning compound is plunged into the pot and held there for about five minutes. In this short period of time the dirt in the metal is forced out and skimmed away. The effect is evident in the solid castings that result from the cleansing.

Another lesson in economy that may be learned from the printer is in salvaging the good metal that is carried away in the dross. This dross contains about 40 per cent of perfectly good metal, and where babbitt is used in large volume the saving of this metal would be substantial. By sprinkling a dross-reducing compound over the top of the molten metal, the metal in the dross is released and flows back into the pot.

WHAT'S NEW IN PLANT EQUIPMENT

Yarway Triplex High-Pressure Blow-Down Combination

THE TWO MAIN VALVES in the accompanying photograph are 2½ inch Yarway seatless Type C high-pressure 1,400 lb.



New valve combination for blowing down high-pressure boilers

valves, the one next to the boiler being an angle valve, and the outboard valve straightway. To the annular space of each valve has been attached a flanged nozzle, and to the flanged nozzle of the angle valve, or valve next to the boiler, is bolted a 1 inch flanged angle valve. The other flange of this is connected by a goose-neck to the nozzle of the straightway valve. This combination was recently installed in a 1,400-lb. central station and represents a design recently developed by Yarnall Waring Company of Philadelphia for high-pressure service.

The reason for this combination is that for large boilers most engineers desire to use as large blow-down valves as possible, 2 inch or 2½ inch size being popular. On the other hand, blowing down these large boilers at 1,400 lb. pressure through a 2 inch or a 2½ inch valve is a troublesome matter, and usually results in the operator merely cracking the valve. When this is done it soon causes the valve to leak, because such valves are not designed for throttling service. This new Triplex arrangement has been designed so that the actual blowing down of the boiler under pressure is done through a 1 inch valve, as shown, which at all times is connected to the boiler by reason of the annular space provided in the Type C seatless valve. Although it is difficult to operate a 2½ inch blow-down valve at high pressure because of the enormous mechanical strains involved, it is relatively easy to operate a 1 inch valve at this pressure.

All three of these valves have double Alemite check fittings, so that the internal parts can be lubricated even under pressure. The valves are also furnished with yoke springs, which maintain a constant pressure upon the packing train and insure thereby long life of the packing. The stem collar in each valve is provided with double ball bearings, to take the thrust of the plunger both ways. Moreover, these three valves are equipped with nitralloy plungers.

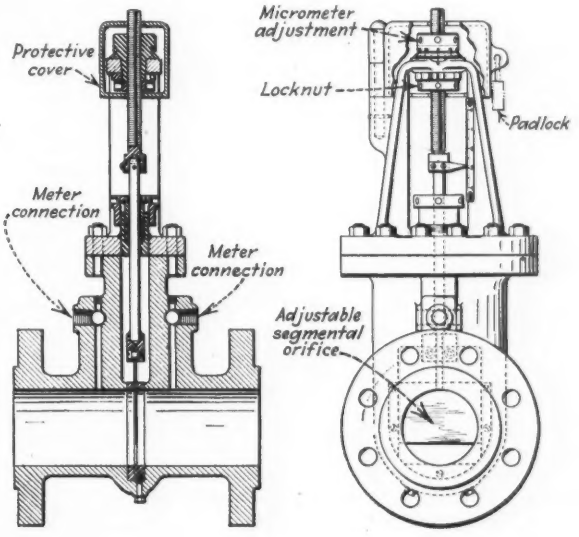
It is the usual practice with valves of this make to have the inlet of the seatless valve on the side of the valve and the two main valves are so connected, but in the case of the 1 inch blow-down operating valve, the inlet is under the plunger. This is done because in this position it is not possible to produce the "hydraulic jack" effect which would be the case were the valve connected the other way and the outside valve happened to be closed. The sequence in operating this triplex blow-down combination is to open the outside 2½ in. straightway valve first, then blow down with the 1 inch angle valve, then close the 1 inch angle valve and finally close the 2½ inch outside straightway valve. In this blow-down cycle the 2½ inch angle valve next to the boiler does not have to be operated.

Adjustable Orifice for Fluid Meter Installations

FOR FLUID METET installations where it is desirable to obtain measurements over a wide range of capacity, the adjustable orifice illustrated has been designed by the Bailey Meter Company, 1036 Ivanhoe Road, Cleveland, Ohio. This adjustable orifice is particularly suitable for use with meters measuring gas or low-pressure heating steam, since on these services the desired capacity is often dependent upon the season.

The adjustable orifice consists of a flanged body with integral meter connections. It can be installed readily in a steam, water or gas line and connected to any differential-head type of fluid meter. The adjustable orifice functions similarly to the fixed type of Bailey segmental orifice. A micrometer adjusting screw permits setting the height of the gate segment within 0.001 in. When it is advisable to change the capacity of the meter it is simply necessary to set the micrometer screw at the reading corresponding to the desired maximum capacity, as obtained from curve sheets furnished with the orifice.

The adjustable orifice permits changing the maximum capacity of the meter as much as 40 to 1 and therefore can take the place of a multitude of fixed orifices, and the change may be made readily without disrupting meter operation or diverting the flow through a bypass line.



Bailey adjustable orifice permits measurements over a wide range of capacity

NEWS of the FIELD

Norris and Commission Bills on Muscle Shoals Reported by Senate and House Committees

ANOTHER step has been taken in the long drawn out controversy over the disposition of the Muscle Shoals project with the reporting of two bills by Senate and House Committees.

The Senate Agriculture Committee has reported favorably on the Norris resolution for government ownership of the Shoals power and fertilizer plants, while a subcommittee of the House Committee on Military Affairs has submitted a proposal which follows closely the recommendations made by the President's Muscle Shoals Commission.

Same Old Norris Bill

Identical with his proposal that died through a pocket veto in the latter part of the Coolidge administration, Senator Norris' resolution would create the "Muscle Shoals Corporation of the United States" to operate the power and fertilizer project. It would proclaim the public policy of the United States to be to utilize the properties for the fixation of nitrogen for agricultural purposes in time of peace and to distribute surplus power "equitably among the states, counties and municipalities within transmission distance." Authority is contained in the resolution for construction of power transmission lines by the government.

House Would Lease Plant

The House bill would provide for liberal leasing of the nitrate facilities, but the Government would control the power switchboard. A commission of three would be appointed by the President and confirmed by the Senate for the purpose of conducting leasing negotiations. Unless a lease could be consummated within eighteen months, the proposal provides that the Government shall take the plant over.

The lessee must agree to run the plant for 50 years. Profits to the lessee would be limited to 8 per cent. Preference would be given to the lessee regarding the power, and in the case of any excess power, priority would be given to states, counties or municipalities. Open bidding would be provided, with preference in the award of the lease to states, counties or municipalities or nonprofit making agricultural agencies.

Cove Creek Dam would be constructed by the Government when the lease is effected, and in the event there is no lease signed within eighteen months, Cove Creek Dam would be constructed on the certification by the proposed commission as to the need for more power.

New York's Largest Pumping Station Put in Operation

THE LARGEST pumping plant in the New York City water supply system which, it is believed, will avert future water shortages, was set in operation March 15, when Mayor Walker pressed an electric button at City Hall.

The new plant, on the south shore of Croton Lake, is expected to stop the annual loss of 20,000,000,000 gal. of water over the spillway of the Croton Dam. Its capacity is 180,000,000 gal. a day, drawing water from Croton Lake and delivering it into the Catskill Aqueduct at a point 170 ft. above the high-water level of the lake. The aqueduct from the Ashokan reservoir passes under the lake and comes up to the surface one-third of a mile from the pumping plant. A 6-ft. delivery main carries the Croton water to the aqueduct.

The cost of the pumping station, according to Commissioner John J. Dietz, of the Department of Water Supply, Gas and Electricity, was $303,735, almost $200,000 less than the original estimate of $500,000.

U. S. Buildings Office to Abandon Own Power Plant

CLAIMING it can buy its electricity more cheaply than it can make it, the Federal Office of Public Buildings and Parks in Washington, D. C., is going out of the power business.

This announcement was made by Lieut. F. B. Butler, assistant to Lieut.-Col. U. S. Grant III, director of the Public Buildings office, in connection with the imminent abandonment of the electric generating plant in the Land Office Building. That plant now supplies electricity for lighting and power to Government offices in the Land Office, Patent Office and Pension Office buildings, and to the Court House.

The Land Office plant will be closed down after this winter, Lieutenant Butler said, and power will be purchased from the Potomac Electric Power Company. It has been the custom heretofore to buy power in the summer season and make it in the winter.

The Public Buildings office already had abandoned an electric generating plant in the State building and is buying electricity for buildings in that neighborhood.

Thorough study preceded the decision, it was stated, with the definite determination that manufacture in comparatively small quantities is accompanied by a higher unit cost than when purchases is made from a company making power on a wholesale scale.

Canadian Government Will Take Over Beauharnois Canal

THE CANAL being constructed by the Beauharnois Light, Heat & Power Company between Lake St. Francis and Lake St. Louis near Montreal, is to be conveyed by the company to the Dominion Government. This provision, contained in the new Order-in-Council, just passed by the Canadian Parliament, specifying the terms, conditions, limitations and reservations upon which the reorganized enterprise will be permitted to divert 53,072 sec.ft. of water from the St. Lawrence, anticipates the carrying out of the larger waterways scheme.

No compensation is to be paid by the Dominion for the canal other than the servitudes, easements or other rights granted. The company's power house, forebay and tailrace and other works required by the company for its hydro-electric power development or future extensions will be in the title of the company, but in no case can there be any interference with navigation in the canal. A prominent feature of the Order-in-Council is that the consent of Parliament will be required if further additional water diversion is sought.

Adequate and suitable supplies of electric power for operating, repairing, lighting and maintaining the canal up to 3,500 hp. maximum demand, must be delivered, free of charge, by the company to the Dominion. In the event of additional power being required, the company must supply this further power at "the lowest contract price with the company."

Under the Order-in-Council, the com-

pany must complete its approved works within five years. Provision is made in regard to the gates to be provided by the company at its power house. The gates must be of such capacity as will discharge 53,072 sec-ft. of water "under the most adverse conditions of head and tail of water level to be anticipated" and to the satisfaction of the government.

Ample protection of the water power rights of the province of Quebec is provided in the order. Another clause leaves the question of the rights over the power open. In other words, if the federal government desires to refer the question of ownership of the power as between the Dominion and the province of Quebec to the Supreme Court of Canada the whole matter can be reopened.

P. G. &. E. Plans Second Gas Line to San Francisco

SAN FRANCISCO is shortly to have a second natural gas feeder line, larger than the 20-in. main that now supplies the city. The Pacific Gas & Electric Company plans immediate construction of 45 miles of 26-in. high-pressure transmission pipe line between the metropolis and Milpitas, where it will tie in with both the Coast and San Joaquin Valley lines from Kettleman Hills.

The project will cost $1,870,000 and will be about six months in construction. It will guarantee San Francisco ample fuel for years to come, the company states, and, besides, will provide an alternate source of supply to guard against possible service interruptions.

Starting at the San Mateo-San Francisco line near the intersection of Alemany and Junipero Serra boulevards, the new main will follow the Skyline boulevard to a point west of Stanford University. From there it will run to a point near the Sunnyvale airship base, and thence through Alviso to the Milpitas metering station.

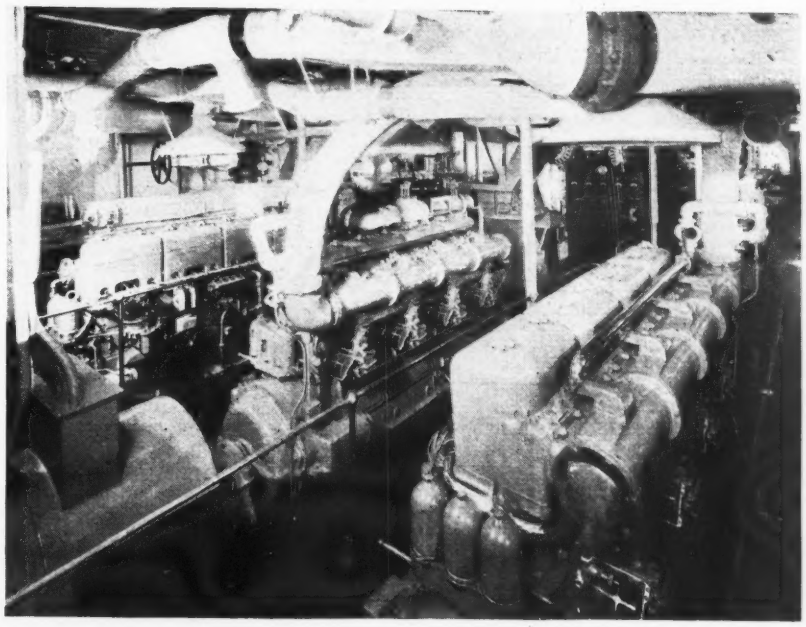
Holding Company Measures Rejected in Massachusetts

THE COMMITTEE on Power and Light of the Massachusetts Legislature reported adversely March 15 on the petition of Senator Frank Hurley, of Holyoke, for legislation to regulate mergers, consolidations or purchases of electric and gas companies by holding companies.

The committee also reported adversely on another petition of Senator Hurley for further regulation of holding companies by the Public Utilities Commission.

A petition of the Public Franchise League for legislation to regulate public utility holding companies was adversely reported by the committee.

2,750-HP. GASOLINE PLANT IN FIREBOAT



New York City's new fireboat, the "John J. Harvey," is fitted with five 550-hp. Sterling gasoline-engine-generators. When in action, four of the main units supply power for the pumps, which handle 16,000 g.p.m. through 32 nozzles, while the fifth unit supplies an electric motor driving the propellers so that the craft may remain in position. Under way the main units furnish power to two motors with a total capacity of 1,165 hp., which propel the boat at a speed of 18 miles per hour

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Power Commission to Work On Regulation of Securities

AS THE RESULT of additions to its staff approved by the House Appropriations Committee, the Federal Power Commission during the next fiscal year intends to devote its attention to carrying out the sections of the water power act authorizing the regulation of the issuance of securities by licensees in states where there is no similar regulation. The House Appropriations Committee in reporting out the independent offices appropriation bill has made the explanation that the 1933 program for the Power Commission contemplates the addition of two new positions. Under the language of the bill, these positions will be filled with one attorney and one assistant chief accountant at $3,800 a year each.

Officials of the Power Commission called attention to the fact during the hearings on the appropriation bill that only half of the states have provided regulatory services having jurisdiction over hydro-electric companies operating on licenses issued by the federal government. Frequently, the licensees of the commission experience some embarrassment in seeking to bring their securities under a legal status sufficient to meet the requirements of certain savings-banks laws, it was brought out. To meet this situation, it was urged that there should be no more delay in permitting the commission to exercise its supervisory powers over securities. The members of the House committee were assured that the work of the commission in this respect will not interfere with state jurisdiction. The Power Commission will only act in cases where there is no state supervision.

The total appropriation for the Federal Power Commission for the fiscal year of 1933 will be $289,270 if Congress adopts the recommendations of the House Appropriations Committee.

British Engineers to Visit America on Aug. 27 - Sept. 9

THIS YEAR the annual summer meeting of the British Institution of Mechanical Engineers will be held in Canada and the United States from Aug. 27 to Sept. 9, inclusive. Members of the institution will sail from Southampton, England, on Aug. 19, arrive at Quebec on the 27th, and proceed to visit industrial plants, power stations and other places of interest in Eastern Canada and this country.

The itinerary of the trip includes universities and plants in Quebec, Montreal, Ottawa and Toronto; the Canadian National Exhibition at Toronto; the power stations at Niagara Falls; the Eastman Kodak works in Rochester; the General Electric plant at Schenectady; and various places of interest in New York City. Individual members may extend the tour to take in additional places in both countries.

Units Ordered for Hydro Project at Palisade, Colo.

RECENT CONTRACT AWARDS to successful bidders bring construction plans on the United States Reclamation Service—Public Service Company of Colorado 3,000-kw. hydro-electric plant at Palisade, Colo., nearer to consummation.

The Reclamation Service, which is supervising the project, has approved these contracts on machinery and equipment: Two 2,300-hp. turbines and governors, to be supplied by the Pelton Waterwheel Company; two 1,875-kva. generators, Electrical Machinery Manufacturing Company, Minneapolis, Minn.; switchboard, Standard Manufacturing Company, Dallas, Texas.

The Palisade project is a joint undertaking in which the Government, the Grand Valley Water Users Association and Public Service Company participate. Public Service Company is financing construction, will operate the plant for 25 years, then relinquish it to the Government for the benefit of the Water Users Association.

Stevens Tech to Run Camp For Vocational Guidance

SEVERAL COLLEGES and some of the major engineering and industrial organizations of the country are represented in an experiment in vocational or collegiate guidance for boys which, according to an announcement March 20 by President Harvey N. Davis of Stevens Institute of Technology, will be made at the Stevens Engineering Camp in northern New Jersey for two weeks next summer, Aug. 13 to 27. One of the more important decisions of a boy's life, President Davis said, is his choice of a college, not so much his choice of a particular college as the type of college for which he is best fitted and which may lead him to a career where he will find satisfaction.

Willis R. Whitney, vice-president of the General Electric Company; Clarence F. Hirshfeld, director of research of the Detroit Edison Company; John C. Parker, president of the Brooklyn Edison Company; Commander E. E. Wilson, president of the Sikorsky Aviation Corporation; Dean Dexter S. Kimball of Cornell University; President Clarence A. Barbour of Brown University; Dr. Roy V. Wright, past-president of the American Society of Mechanical Engineers and editor of *Railway Age;* Dr. H. Foster Bain, former Director of the Bureau of Mines, are among those named in the list of camp lecturers announced by President Davis.

Individual and group tests intended to help each boy to estimate his natural characteristics and abilities will be administered by Dr. Walter Van Dyke Bingham, director of the Personnel Research Federation of New York, and Prof. Johnson O' Connor, formerly personnel officer, General Electric Company.

Boys now in high school and preparatory schools, preferably those who will enter college a year from next September, in 1933, are to attend the camp. Dr. Davis said that every effort had been made to assure the impartiality of the guidance offered through the camp.

COMING CONVENTIONS

American Society of Mechanical Engineers. Spring meeting at Bigwin Inn, Lake of Bays, Ont., Canada, June 27-July 1. Oil and Gas Power meeting at Pennsylvania State College, June 8-11. Secretary, Calvin W. Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers. District meeting at Providence, R. I., May 4-7. Annual summer convention at Cleveland, Ohio, June 20-24. Heaquarters, 33 West 39th St., New York.

American Boiler Manufacturers Association. Annual convention at the Greenbrier Hotel, White Sulphur Springs, W. Va., May 23-25. Secretary, A. C. Baker, 801 Rockfeller Building, Cleveland, Ohio.

American Society for Testing Materials. Annual meeting at Chalfonte-Haddon Hall, Atlantic City, N. J., June 20-24. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

American Water Works Association. Annual convention at the Hotel Peabody, Memphis, Tenn., May 2-6. Secretary, Beekman C. Little, 29 West 39th St., New York City.

American Welding Society. Annual meeting in New York City, Apr. 27-29. Secretary, M. M. Kelly, 33 West 39th St., New York City.

Association of Iron and Steel Electrical Engineers. Annual convention in Pittsburgh, Pa., June 20-24. Managing Director, John F. Kelly, Empire Building, Pittsburgh.

Fifth Annual Midwest Bituminous Coal Conference. At Purdue University, Lafeyette, Ind., Apr. 14-15. Secretary, W. A. Knapp, Engineering Experiment Station, Purdue University, Lafayette, Ind.

National District Heating Association. Annual convention at the William Penn Hotel, Pittsburgh, Pa., June 14-17. Secretary, D. L. Gaskill, Greenville, Ohio.

National Electric Light Association. Annual convention in the Atlantic City Auditorium and Convention Hall, Atlantic City, N. J., June 6-10. Secretary, A. Jackson Marshall, 420 Lexington Ave., New York City.

SECTION MEETINGS

A.S.M.E., Metropolitan Section. Petroleum Division meeting in Room 502, Engineering Societies Building, Apr. 8 at 8 p.m. Subject: "Physical and Thermal Properties of Hydrocarbon Mixtures at High Temperatures and Pressures," W. K. Lewis.

A.S.M.E., Providence Section. Meeting in the Society Rooms, Apr. 5 at 8 p.m. Subject: "Engineering Responsibilities in the Pure Air Problem," Ely C. Hutchinson.

N.A.P.E., Philadelphia Locals. All-day meeting in conjunction with other engineering organizations, to be known as "Power Engineers' Day," at the Penn Athletic Club, Apr. 2. Technical sessions and entertainment.

Frank G. Baum, Noted Hydro-Electric Engineer, Dies

FRANK G. BAUM, consulting hydro-electric engineer and one of America's chief authorities on long-distance transmission, died March 14 at Redding, Calif. He was 61 years old.

With his adaption of synchronous condensers to power systems in 1927, Mr. Baum solved the problem of economical transmission of large quantities of electricity over distances of hundreds of miles.

Mr. Baum was born in Ste. Genevieve, Mo., and was educated at Stanford University, from which he was graduated in 1898 with the degree of Bachelor of Arts, receiving the degree of Electrical Engineer the next year. Between 1898 and 1907 he was electrical engineer and chief engineer of the Pacific Gas and Electric Company, and after 1907 was construction chief for the same company.

Mr. Baum was identified with much important work in hydro-electrical engineering and construction. He attained an international reputation, which took him to France and Germany as a consultant for power concerns. He returned to California recently and established extensive laboratories in the mountains of northern California for the investigation of electrical engineering problems.

He was a member of the American Society of Mechanical Engineers, American Institute of Electrical Engineers and American Society of Civil Engineers.

I.E.C. 50th Anniversary Congress at Paris in June

ENGINEERS of many nations will participate in the International Electrical Congress in Paris, France, in June, which is a 50th anniversary celebration of a similar congress held in 1881, also in Paris.

Plans for the meeting originated with a group of French technical societies in cooperation with the International Electrotechnical Commission, a body organized twenty years ago to handle and direct all technical electrical engineering matters having an international aspect.

Recognition of America's important contributions toward engineering and scientific progress is seen in the fact that many engineers of this country have been invited to prepare technical papers for the congress. Among these are "Survey of Progress in Electrical Machinery in the United States," F. D. Newbury; "Stability of Power Systems," R. D. Evans and C. Wagner; "Industrial Furnaces," W. S. Scott; "Electric Welding," A. M. Candy and J. G. Ritter; and "Electric Power Development in the United States," F. C. Hanker.

Personals

L. C. STANG, vice-president and general manager of the Columbus, Delaware & Marion Electric Company, has been elected also vice-president in charge of operations of the Ohio Electric Power Company. Mr. Stang entered the power field in 1913 with the Des Moines Electric Company, working in several different departments. In 1916 he became associated with Sargent & Lundy of Chicago as engineer in charge of power plant design. After the war he joined the Columbus, Delaware & Marion company as superintendent of the light and power department, and was elected vice-president in 1929.

DR. VANNEVAR BUSH, professor of electrical engineering at the Massachusetts Institute of Technology, has been appointed vice-president of the institute and dean of engineering as well as a member of the corporation. Dr. Bush is known for his achievements in power system research and technical education.

A. H. DICKINSON, formerly research assistant in the department of fuel and gas engineering at the Massachusetts Institute of Technology, has joined the International Business Machine Corporation, New York City, as assistant engineer. While a member of the M.I.T. research staff, Mr. Dickinson developed a method for the more accurate calibration of high-pressure gas meters.

T. S. BURNS has been made senior engineer of the United States Engineers Office, Huntington, W. Va. Mr. Burns in 1930 was senior hydro-electric engineer of the United States War Department, in charge of preparation of power reports for the Pittsburgh district, and prior to that was estimating engineer with the Pennsylvania Water & Power Company, in charge of estimates on the Safe Harbor project on the Susquehanna River.

B. S. BESSESEN, an associate engineer in the United States Civil Service, who has been acting superintendent of the Muscle Shoals development, Ala., for the past year, now has received his appointment as superintendent. Mr. Bessesen has held responsible positions in power development projects in the West and from 1922 to 1924 was instructor in electrical engineering at Oregon State College.

E. S. FITZ, manager of production and transmission for the past year for the Virginia Electric & Power Company, recently was appointed general manager of the electric department for the entire system which serves tidewater Virginia and northeastern North Carolina. His new position gives him charge of distribution as well, and he will continue to make Richmond headquarters.

How's Business?

ALTHOUGH some slight slow improvement in the banking position is perceptible, the pressure toward expansion under Federal Reserve open-market policies is still disappointingly feeble. The attitude of member banks toward cooperation with administration efforts for credit expansion continues uncompromisingly sceptical about the possibility of speeding recovery. In consequence, commodity prices continue weak and business activity still shows almost no sign of response to spring stimuli, although it seems to grow no worse. Steel production has relapsed slightly under postponement of Ford production plans, and building prospects for March are less encouraging than the February figures indicated, but merchandise carloadings and electric power production, 1,538,452,000 kw. for the week ended March 12, according to the N.E.L.A.) show some relative improvement recently.—*The Business Week*, March 23.

Business Notes

INTERNATIONAL-STACEY CORPORATION, Columbus, Ohio, and its subsidiary companies announce that their Fort Worth (Tex.) offices have been moved to Room 307, Southland Life Insurance Company, Dallas, Tex. F. W. Mohler, Midcontinent sales manager; C. B. Coldwell, sales engineer for the Stacey and Roots-Connersville-Wilbraham divisions; and S. B. Creamer, sales engineer for the International Derrick & Equipment Company, will be located in the Dallas office.

TUBE-TURNS, INC., Louisville, Ky., has appointed the Pacific Pipe & Supply Company, Los Angeles, Calif., as jobbers of its pipe products.

CHAPLIN-FULTON MANUFACTURING COMPANY, Pittsburgh, Pa., announces the appointment of C. H. Collins, 628 Dwight Building, Kansas City, Mo., as its sales representative in that territory.

DIAMOND ELECTRIC MANUFACTURING COMPANY, Los Angeles, Calif., which recently took over the Mosher Manufacturing Company, Denver, Colo., plans to establish a factory in Denver soon. D. G. Kendall, of San Francisco, is to be local plant manager and will supervise the new plant's operations.

BLAW-KNOX COMPANY, Pittsburgh, Pa., and the WESTERN PIPE & STEEL COMPANY of San Francisco and Los Angeles, Calif., have closed an agreement whereby the latter will manufacture Blaw-Knox products on the Pacific Coast and will sell them through the organization of a new company to be known as the Blaw-Knox & Western Pipe Corporation. This new concern will be equally owned by the two companies.

GOULDS PUMPS, INC., Seneca Falls, N. Y., announces the appointment as works manager of Hamilton Garnsey, Jr. Joining the Gould's organization in 1923, Mr. Garnsey was made foundry engineer in 1925 and assistant to the general manager in 1929. His appointment as works manager follows his recent designation as assistant to the president.

Trade Catalogs

MATERIALS HANDLING—A full line of portable handling machinery for the loading, unloading and storage of coal, coke, cinders, sand, gravel, crushed stone, fertilizer and other loose materials, is well illustrated and described in Catalog No. 530 which the Jeffrey Manufacturing Company, Columbus, Ohio, has just published.

REFRACTORIES — Bulletin 460, just issued by the Denver Fire Clay Company, P. O. Box 1107, Denver, Colo., describes and illustrates the new P.C.E. furnace, developed by Messrs. Phelps and Cartwright, industrial fellows of the Mellon Institute, for determining the pyrometer cone equivalent of refractory materials.

COMPRESSORS, FANS—Two illustrated bulletins, covering centrifugal compressors and fans, have just been issued by the B. F. Sturtevant Company, Hyde Park, Boston, Mass. Bulletin No. 386 describes the construction of Design 9 centrifugal compressor and gives tables of ratings and performance curves, while information on the mechanical features and ratings of convertible multivane fans is contained in Catalog No. 370.

METAL PRODUCTS—The 1932 issue of the "Buyers' Guide: Nickel Alloy Steel Products" has just been released by the International Nickel Company, 67 Wall St., New York City. This convenient reference bulletin is a directory of manufacturers, fabricators and distributors of structural-grade nickel steels, corrosion-resistant steels, heat-resistant nickel-chrome-iron alloys, special ferro-nickel alloys, and special services.

REGULATORS—The complete line of pressure and flow regulators manufactured by the Mercon Regulator Company, 1 LaSalle St., Chicago, Ill., is described and illustrated in the company's new Catalog No. 5. This publication includes a full account of the new adjustable-port features and the new liquid-level controller line.

NEW PLANT CONSTRUCTION

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Los Angeles—Board of Water & Power Commissioners of Los Angeles, adopted resolution of intention to ask voters at city election to be held May 3, to approve power bond issue of $34,400,000. The board's resolution instructs the city attorney to prepare necessary resolution requesting city council to submit the proposition to voters on ballot. The bond fund requirements are listed as $17,500,000 for transmission line from Hoover Dam, $11,240,000 for steam plant at Wilmington and necessary betterments of existing electric system. $5,660,000.

Colo., Colorado Springs—City, c/o E. L. Mosley, Mgr., will receive bids from engineering firms to prepare specifications for addition to steam power plant including 5,000 kw. 80 per cent power factor turbo-generator set, boiler and steam generating unit with auxiliary and appurtenances. Estimated total cost $260,000. L. H. Shute, Supt. Municipal plant.

Colo., Denver—City plans to expend $300,000 for modernizing water system including machinery, wiring and other equipment and replacing present steam pumping plants with electric pumps, to be completed within two years, under contract signed on March 1 by Water Commission and Public Service Commission of Colorado which will furnish power for the project.

Mass., Boston—Quincy Market Cold Storage & Warehouse Co., 8 T. Wharf, having plans prepared for addition and extensions to boiler house. Estimated cost $40,000. Private plans. Foundation awarded to Aberthaw Co., 80 Federal St., Boston.

Mo., Washington—Burns & McDonnell Engineering Co., 406 Interstate Bldg., Kansas City, has been retained to make an appraisal and survey to determine whether it would pay to construct municipal light plant or possibly get a cheaper rate from Union Co. City is under franchise with Union Electric Light & Power Co.

N. J., Long Branch — Monmouth Memorial Hospital, Third Ave., plans construction of internes quarters, hospital, power house and laundry at Third and Pavillion Aves. Estimated cost $150,000. Architect not announced.

N. J., Newark—Owner, c/o Paul C. Reilly, 111 5th Ave., New York, N. Y., having plans prepared for construction of a 2 story, 60 x 110 ft. laundry and power house. Estimated cost $40,000.

N. J., Newton—M. K. Pickett & Sons, 21 Townsend St., will build a 1 story artificial ice manufacturing plant on Water St. Estimated cost $40,000. Private plans. Work will be done by separate contracts.

New York—Niagara-Hudson Power Co., 15 Broad St., New York, plans to expend $19,301,000 during 1932 for improvements and extensions of facilities. Plans include electric distribution lines, $7,625,000; improvement and extension of electric transmission lines; $5,706,000; extension and improvement of gas system in eastern and central divisions, $2,222,000; building construction including completion of new service center at Syracuse, $1,933,000; work on hydro-electric stations and steam generating plants, $1,815,000.

N. C., Roanoke Rapids—Sanitary District Board, A. J. Young, Chn., will soon award contract for improvements to sewage system including pumping station, pumping equipment etc. Spoon & Lewis, Greensboro, are engineers.

Pa., Pitcairn—Borough of Pitcairn, W. M. Hicks, Secy., 320 Center Ave., will receive bids until April 1 for furnishing, delivering and erecting water cooling tower either atmospheric or forced draft type of towers of minimum capacity 660 g.p.m. for raw water cooling in connection with heat exchangers, for cooling jackert water on 960 hp. and 360 hp. Diesel engines for municipal electric light plant.

Pa., Plymouth—Glen Alden Coal Co., awarded contract for dismantling Pettebone Colliery steam plant and moving and erecting same at Lane Colliery here to A. J. Sordoni, Owen St. Estimated cost $100,000.

Pa., Rockview—State Department of Property & Supplies, Harrisburg, plans completed for construction of a 1 story, 54 x 108 ft. boiler house, including coal bunkers, moving four 200 hp. boilers from old location to new, two handfired, two equipped with stokers for coal or powdered fuel, also new steam tunnel to cell block, and erection of stack 175 ft. high at State Penitentiary here. J. N. Chester Engineers, Clark Bldg., Pittsburgh, are engineers.

Tex., El Paso—U. S. Government, c/o Lieut. Col. M. K. Ireland, Constructing Quartermaster, will receive bids until March 24 for installing water heating system in central heating plant, Wm. Beaumont and general hospital, including dismantling present pre-heated feed water tanks, changing location of two feed water pumps, altering boiler for water heater, aerating water tank for pre-heated boiler feed water, pipe work, excavation for foundation, construction of pent house for pump room.

Wash., Vancouver—City, c/o A. J. Collins, Chn. City Lighting Comm., plans construction of a new Diesel engine light plant.

N. F., St. Johns—Department of Public Works, plans to expend $70,000 to $75,000 for alterations to government cold storage plant.

Que., Sherbrooke—Central Quebec Light, Heat & Power Co., will soon receive bids for construction of a hydro electric development on St. Francis River. Estimated cost $1,250,000.

Equipment Wanted

Boiler, Soot Blower, etc.—Anthony, Kan.—City plans to purchase a 350 hp. superheat boiler, soot blower, etc., in connection with improvements to water and light plant. $35,000.

Boilers—Brookline, Mass.—Board of Selectmen, 329 Washington St., plans installation of new boilers, etc., in connection with alterations to heating and lighting plant at 46 Toppan St.

Boilers, Pumps, Etc.—Elgin, Ill.—City will receive bids until April 18 for boilers, sludge pumps, and miscellaneous electrical equipment in connection with sewage treatment plant. Estimated cost $50,000.

Boilers, Stack, Etc.—Cleveland, O.—Board of Education, F. G. Hogan, will receive bids until April 11 for boilers, stack and coal vault for central heating plant at high school building. Estimated cost $40,000.

Engine—Bridgeville, Pa.—Mayer Brick Co., F. C. Mayer, plans installation of a 150 to 200 hp. Diesel engine.

Motors—Melbourne, Australia—City Clerk will receive bids until April 11 for supply of one 7½ hp., three 8 hp. and two 10 hp. 400 v. 3 ph. lift motors complete with lift control gear.

Power Plant Equipment—Rostraver, Pa.—U. S. Engineer Office, Keenan Bldg., Pittsburgh, will receive bids until April 6 for power plant equipment, including transmissions complete, automatic driven controls, accumulator control valves, coal hoist and automatic bypass at Dam No. 4 here.

Pump—Vallejo, Calif.—City, A. Edgcumbe, Clk., plans to purchase a 1,000 g.p.m. pump for municipal water plant.

Pump, Etc.—Greenville, Miss.—Guy Drew, City Clk., will receive bids until April 5 for furnishing vertical type wood trash pump, direct connected to 40 hp. squirrel cage 220 v., 3 ph., 60 cycle motor, designed for starting across line, also one 1,000 g.p.m. G. E. starter pump.

Pump, etc.—Huntington, W. Va.—U. S. Engineer Office, War Department, will receive bids until March 28 for 200 g.p.m. electric motor driven vertical triplex plunger oil pump against 430 lb. pressure and driven through silent chain by 60 hp., 900 r.p.m. low starting current motor, for operation on 400 v., 3 ph., 60 cycle a.c. complete with electrical control for temporary operation, also pump-priming tank, 700 gal. capacity.

Pumping Equipment—Williston, N. D.—City will soon receive bids for pumping equipment, etc., for proposed waterworks improvements. Estimated cost $60,000.

Pumping Unit—Lake Forest, Ill.—City, Albert D. Farwell, Mayor, will receive bids until March 30 for 3,600 g.p.m. dual driven horizontal centrifugal pumping unit in connection with waterworks.

Pumps—Council Bluffs, Ia.—City plans installation of auxiliary pump and a new pump of higher pressure at Glendale Station. Estimated cost $150,000.

Pumps—Two Harbors, Minn.—City plans to purchase two electrically driven pumps for waterworks.

Pumps—Williston, N. D.—City will receive bids until April 4 for 900 g.p.m. high service pump, 3,000 g.p.m. wash pump, 800 and 460 g.p.m. low service pumps, etc., in connection with waterworks improvements. $15,000.

Pumps—Orrville, O.—Board of Public Affairs, A. D. Webster, Secy., will receive bids in April for two motor driven centrifugal water pumps for water cooling system.

Pumps, Motors, Transformers, Etc.—Wilmette, Ill.—Village will receive bids until April 5 for furnishing and installing pumps, motors, transformers, switchboard, lighting equipment, engine generator unit, gas and oil engines, etc., in connection with waterworks improvements. Estimated cost $500,000.

Ventilation Equipment—New York—Board of Transportation, J. H. Delaney, Chn., 250 Hudson St., New York, will receive bids until April 5 for furnishing and installing ventilation equipment for Line D from 8th Ave. to Roosevelt Ave. and Line E. from Nassau Ave. to Queens Plaza forming a part of Independent System of City-owned Rapid Transit Railroads in Boroughs of Manhattan, Queens and Brooklyn.

Industrial Projects

Conn., Thomaston—Eclipse Glass Co., H. O. Vogt, Treas., awarded contract for a 1 story, 55 x 120 ft. factory including boiler room on North Main St. to A. Tamburini, 1641 Baldwin St., Waterbury. Estimated cost $40,000.

Ind., Marshall—Kraft-Phoenix Cheese Co., 400 Rush St., Chicago, Ill., will build factory to include boiler room, new boilers and equipment, etc., near here. Estimated cost $25,000. Work will be done by day labor.

Mo., Keokuk—Kane, Dunham & Kraus, Inc., 1709 Locust St., St. Louis, having preliminary plans prepared for construction of a shoe factory here. Estimated cost $40,000.

O., Cleveland—Industrial Rayon Co., Hiram S. Rivitz, Pres., West 98th St. and Walford Road, awarded contract for 1 story, 80 x 430 ft. addition to factory to George A. Rutherford Co., 2725 Prospect Ave. Estimated cost $150,000.

Pa., Edgley—Paterson Parchment Paper Co., awarded contract for a 2 story, 250 x 270 ft. addition to factory to F. G. Petitt Construction Co., Paterson, N. J. Estimated cost $200,000.

Pa., Brockway — Brockway Machine Bottle Co., receiving bids for construction of a 1 story, 35 x 100 ft. factory. Russell G. Howard, Dep. National Bank, DuBois, is architect.

Utah, Siguard—Jumbo Plaster & Cement Co., c/o J. Greenwood, Salt Lake City, will soon award contract for structural steel for reconstruction of plaster mill recently destroyed by fire. Estimated cost $250,000.

Wyo., Casper—Midwest Refining Co., awarded contract for electrifying Midwest and Standard refineries here to Stearns-Rogers Manufacturing Co., 1720 California St., Denver, Colo. $150,000.

N. S., Baddock—North American Gypsum Co., having plans prepared by own staff for construction of a gypsum factory. Estimated cost $150,000.

Ont., Fort William—Soo Falls Brewing Co., 503 Bay St., Saulte Ste Marie, plans construction of a plant for the manufacture of soft drinks including cold storage plant here. $30,000.

Que., Montreal—Joseph Elie Ltd., 393 Hibernia Road, plans construction of an oil refinery on Sherbrooke St. E. Estimated cost $1,000,000.

Que., Montreal—Lighting Appliance Inc., 9 Desbrosses St., New York, N. Y., plans construction of a branch plant for the manufacture of residential lighting fixtures here. Estimated cost to exceed $40,000.

Que., Montreal—Standard Wall Paper Co., Hudson Falls, N. Y., plans construction of a branch plant here.

Que., Three Rivers — Canada Iron Foundries Ltd., plans construction of a plant for the manufacture of water pipe valves. Estimated cost $100,000. Private plans.

Argentina, La Plata—Minister of Agriculture de Tomaso, Buenos Aires, plans to expend $1,250,000 on construction of a refinery for preparation of lubricants which will handle 400 tons of crude oil daily here.